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HEIGHTS AND WEIGHTS OF SCOTTISH SCHOOLCHILDREN

BY

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The series of investigations which form the subject of this account deal on a broad basis with questions relating to the height and weight of children attending Scottish education authority schools.

I. Object and Scope of Inquiry

Attention is given solely to cross-sectional or distance studies, that is to say, to the measurements at various ages of large numbers of children of different generations or of different geographical-industrial groups.* Concern is with children aged 5, 9, 13, and, in certain instances, 16 years, these being the ages at which children attending education authority schools undergo systematic medical examination in Scotland.

The material for presentation and analysis is divisible into four groups:

(1) Average heights and weights of children in Edinburgh and Glasgow during the past 40 years, 1913–14 to 1953–54.

(2) Average heights and weights of children in three of Scotland's main cities (Edinburgh, Glasgow, and Dundee) and one of its most populous counties (Ayrshire), the four areas together forming a representative cross-section of the school population in the central industrial belt, for the six school sessions, 1948–49 to 1953–54.

(3) Average heights and weights of Scottish children on a regional basis, for the sessions 1951–52 and 1952–53.

(4) Average heights and weights of children of four highly industrial large burghs (Dumbarton, Falkirk, Kilmarnock, and Kirkcaldy) and four less industrial large burghs (Perth, Stirling, Ayr, and Dunfermline), 1952–53.

* Nearing completion is a further series of investigations which relate both to the cross-sectional studies, in respect of school children of different socio-economic groups, and to longitudinal or velocity studies.

II. Details of Investigations

(1) Edinburgh and Glasgow: Mean Heights and Weights of Children attending Education Authority Schools examined at Systematic Medical Inspections at 5, 9, and 13 years, at Intervals from 1913–14 to 1953–54.

In Scotland, relatively few education authorities can provide, from the early years of the school health service up to the present time, anything approaching a complete record of the average heights and weights of children aged 5, 9, and 13 years. This is due in part to the variation that existed from area to area, before session 1938–39, in the age groups selected for systematic medical examination. Glasgow is fortunately placed in this respect, but this circumstance has not been without disadvantage, for, as a consequence of the frequent quotation of the relatively low average heights and weights for Glasgow schoolchildren of 30 or 40 years ago and the relatively high increases in the average measurements of the children of that city in the past 20 years, there has been a tendency to accept these increases as typical of those of Scottish schoolchildren as a whole.

It is certain that there has been a general increase in the average heights and weights of schoolchildren of the various age groups (dealt with at systematic medical examinations) throughout Scotland during the past two decades, but, in the absence of reasonably complete records of past heights and weights for a representative cross-section of the school population, the precise extent of the increases for Scottish schoolchildren as a whole during the period in question must remain a matter for conjecture.

Even the somewhat less marked increases in the average measurements of children attending Edinburgh education authority schools cannot be accepted as representative of those for Scottish schoolchildren as a whole, but the particulars for Edinburgh and Glasgow together may justifiably be regarded as illustrating such increases in most populous industrial centres during recent decades.

Appendix Table A, which deals with the average heights and weights of children aged 5, 9, and 13 years attending education authority schools in Edinburgh and Glasgow, shows the extent to which the average measurements have increased during the course of the past 40 years in these two cities. The choice of school sessions at irregular intervals is occasioned by the non-existence of height and weight records for Edinburgh schoolchildren during the recent war and by the fact that in that city, for a period of some years, not only was the systematic medical examination of the 9-year-olds discontinued but the examination of the older children was postponed from age 12 to age 13.

In Appendix Table A the actual average measurements of the schoolchildren of both Edinburgh and Glasgow for sessions 1953–54 and 1949–50 (and for 1937–38 as well in the case of Glasgow) have been adjusted to the uniform ages of $5\frac{4}{12}$, $9\frac{5}{12}$, and $13\frac{5}{12}$ years, use being made of the factors (that is, the average rates of increase in height and weight per month of age) employed in Glasgow in recent years in the adjustment of the average measurements of the local children to these particular uniform ages. As to the earlier sessions, the average ages when the children were measured approximated closely to the uniform ages mentioned above.

Two points are worthy of note:

(*a*) The average heights and weights for 1953–54 for boys and girls of all these age groups in both Edinburgh and Glasgow are greater than the corresponding averages for 1913–14, and all the differences are statistically significant.* The actual mean differences are set out in Table I.

At the end of the first world war and in the school sessions immediately thereafter, it was found that most of the average heights and weights fell short of those recorded in session 1913–14. By 1931–32 a few of the average heights and weights given in Appendix Table A had shown signicant increases over those for 1913–14, but it is during the past 20 years that the increase in average measurements has steadily risen to a level approaching that for 1953–54.

Special comment is desirable concerning the average height of 13-year-old Edinburgh schoolgirls. This was 59 in. in 1913–14, but the average height from 1909–10 to 1926–27 was regularly between 56 and 57 in. (1912–13, with 58·4 in., and 1913–14, with 59 in., being exceptional), and it was not until 1927–28 that an average height of 58·5 in. was reached. With this point in mind, therefore, it may be stated in general terms that between 1913–14 and 1953–54 the following increases took place in the average measurements of Edinburgh and Glasgow schoolchildren (Table II).

* In this article, instances where the amount by which an observed difference exceeds its standard error is not stated with precision, the use of the word "significant" implies that the difference between two proportions or two averages is at least twice its standard error.

TABLE I

CITIES OF EDINBURGH AND GLASGOW EDUCATION AUTHORITY SCHOOLCHILDREN
INCREASE IN MEAN HEIGHTS AND WEIGHTS BETWEEN 1913–14 AND 1953–54

Age (yrs)		5		9		13	
City		Edinburgh	Glasgow	Edinburgh	Glasgow	Edinburgh	Glasgow
Boys	Increase in Mean Height (in.)	1·29	1·93	2·92	4·00	3·57	3·91
	Increase in Mean Weight (lb.)	2·07	4·35	7·45	8·36	14·37	14·53
Girls	Increase in Mean Height (in.)	1·04	1·64	2·30	2·53	0·85	3·18
	Increase in Mean Weight (lb.)	1·31	3·69	7·19	6·98	12·68	16·41

TABLE II

CITIES OF EDINBURGH AND GLASGOW EDUCATION AUTHORITY SCHOOLCHILDREN
APPROXIMATE GAINS IN AVERAGE MEASUREMENTS BETWEEN 1913–14 AND 1953–54

City	Age (yrs)	Boys		Girls	
		Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
Edinburgh	5	1¼	2	1	1¼
	9	Nearly 3	7½	2½	7½
	13	3½	14¼	Nearly 3	12½
Glasgow	5	Nearly 2	4¼	1½	3½
	9	4	8½	2½	7
	13	Nearly 4	14½	Nearly 3¼	16½

(*b*) As may be seen from Appendix Table A, the average heights and weights of Edinburgh schoolchildren of the various age groups in 1913–14 were all greater than those of the Glasgow schoolchildren of corresponding age, but as the years have passed there has been a progressive closure of the "gaps" in most instances. Thus, for 1953–54, the average measurements of the Edinburgh children are greater:

For boys:
by 0·36 in. and 0·62 lb. at 5 years,
by 0·32 in. and 0·89 lb. at 9 years,
by 0·56 in. and 2·34 lb. at 13 years;
For girls:
by 0·24 in. and 0·21 lb. at 5 years,
by 0·17 in. and 1·81 lb. at 9 years,
by 0·37 in. and 1·57 lb. at 13 years.

Despite the progressive closure of the "gaps" between the average measurements of the children of the two cities, as many as eleven of the twelve differences are still of statistical significance (the difference being at least three times its respective standard error in ten instances, and 2·2 times its standard error in the remaining instance, that relating to the height of 9-year-old girls); the difference which is not of statistical significance is that in respect of the weight of 5-year-old girls.

It is not without interest to find, on studying the measurements of the Glasgow schoolchildren for the past 15 years, that the proportionate increases in average height and weight between 5 and 9 years, 9 and 13 years, and 5 and 13 years, are more or less identical for children born in 1925 and in subsequent years up to and including 1940 (these increases being greater, of course, for girls than for boys between 9 and 13 years, and 5 and 13 years.) These proportionate increases are set out in Table III:

TABLE III

CITY OF GLASGOW

CHILDREN BORN IN 1925 AND IN SUBSEQUENT YEARS

PERCENTAGE INCREASES IN AVERAGE MEASUREMENTS

Period (yrs)	Boys		Girls	
	Height	Weight	Height	Weight
5– 9	21·5	47·0	21·0	48·0
9–13	15·5	46·0	17·5	58·0
5–13	40·0	115·0	43·0	135·0

This position arises directly from the fact that for Glasgow schoolchildren in the past 15 years, as for London schoolchildren during the period 1938–49 (Daley, 1950), the change in weight has been proportionate to the change in height, with the result that the ratio of weight to height has remained more or less steady. The report on the London investigations summarized the position thus:

> The fact that bone and flesh have kept pace with each other, despite substantial changes in the absolute values of height and weight, suggests that with improved nutrition in schoolchildren, nature has maintained her own balance; that children of to-day are not merely heavier or merely taller than their parents were, but are members of a generation altogether of greater physique.

In the report on the London investigation, use was made of the metric system in calculating the weight to height ratio, and for 1938 and 1949 alike, the ratio of average height (cm.) to average weight (kg.) was as follows:

For boys:
0·17 at 5 years,
0·21 at 9 years,
0·27 at 13 years.
For girls:
0·17 at 5 years,
0·21 at 9 years,
0·28 at 13 years.

For the Glasgow schoolchildren, the corresponding values—which have varied only slightly throughout the 15-year period—are set out in Table IV:

TABLE IV

RATIO OF AVERAGE HEIGHT (cm.) TO AVERAGE WEIGHT (kg.) OF GLASGOW SCHOOLCHILDREN (1938–54)

Age (yrs)	Boys	Girls
5	0·175	0·170
9	0·215	0·210
13	0·270	0·280

(2) EDINBURGH, GLASGOW, DUNDEE, AND AYRSHIRE: MEAN HEIGHTS AND WEIGHTS OF CHILDREN AGED 5, 9, 13, AND 16 YEARS ATTENDING EDUCATION AUTHORITY SCHOOLS, SESSIONS 1948–49 TO 1953–54.

Appendix Table B shows the average heights and weights of the boys and girls measured at the time of systematic medical examination in these four areas. The actual measurements have been adjusted, however, to the uniform ages of $5\frac{4}{12}$, $9\frac{6}{12}$, $13\frac{6}{12}$, and $16\frac{7}{12}$ years. For the 5, 9, and 13-year-olds, use is made of the factors employed in recent years in Glasgow in adjusting the average measurements of children of these ages. For the 16-year-olds, the corresponding factors for the Edinburgh children are used, since these are even more up-to-date (being based on the results of personal investigations concerning the measurements of pupils of this age during the three school sessions, 1951–52 to 1953–54).

Concern here is primarily with two related questions—on comparing the figures for 1953–54, first with those for 1948–49, and secondly with those for 1952–53, are the differences in average heights and weights of statistical significance?

As to the comparison of the figures for 1953–54 with those for 1948–49, Table V (upper half) summarizes the relevant particulars from Appendix Table B, and shows the differences for each age group in respect of height and weight, and the amount by which each difference is greater than its standard error. All these sixteen differences favour session 1953–54 and all are of statistical significance.

In like fashion, Table V (lower half) summarizes the essential points for the two sessions, 1952–53 and 1953–54.

For the boys, all the eight differences except one favour session 1953–54; the difference is at least three times its standard error in six instances, only that relating to the height of the 16-year-olds not being of statistical significance. Exceptionally, the average weight of the 5-year-olds in 1952–53 is

TABLE V

CITIES OF EDINBURGH, GLASGOW, AND DUNDEE, AND COUNTY OF AYRSHIRE
MEAN HEIGHTS AND WEIGHTS AT $5^{4}/_{12}$, $9^{4}/_{12}$, $13^{4}/_{12}$, AND $16^{7}/_{12}$ YRS
COMPARISON OF FIGURES FOR 1953–54 WITH THOSE FOR 1948–49 AND 1952–53

Sex	Session	Age (yrs)							
		5		9		13		16	
		Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
Boys	1948–49	42·65	42·36	51·69	63·49	59·00	90·01	66·86	130·60
	1953–54	42·73	42·54	51·82	64·09	59·56	93·37	67·64	134·48
	Difference	0·08	0·18	0·13	0·60	0·56	3·36	0·78	3·88
	t =	3·9	3·6	4·2	5·6	12·8	15·1	7·3	5·7
Girls	1948–49	42·19	40·69	51·04	60·72	59·35	94·22	63·49	121·24
	1953–54	42·48	41·10	51·34	62·45	59·96	97·37	63·63	122·81
	Difference	0·29	0·41	0·30	1·73	0·61	3·15	0·14	1·57
	t =	13·8	7·8	9·5	14·4	16·6	14·7	4·5	2·1
Boys	1952–53	42·65	42·61	51·55	63·29	59·40	92·68	67·55	132·39
	1953–54	42·73	42·54	51·82	64·09	59·56	93·37	67·64	134·48
	Difference	0·08	0·07	0·27	0·80	0·16	0·69	0·09	2·09
	t =	4·1	1·4	8·9	7·5	3·7	3·1	0·8	3·1
Girls	1952–53	42·34	40·96	51·30	61·60	59·84	96·72	63·64	122·70
	1953–54	42·48	41·10	51·34	62·45	59·96	97·37	63·63	122·81
	Difference	0·14	0·14	0·04	0·85	0·12	0·65	0·01	0·11
	t =	7·0	2·8	1·1	7·1	3·3	3·0	0·1	1·5

above that of those in 1953–54 but the difference is not statistically significant.

For the girls, seven of the eight differences favour 1953–54; five are significant, the difference being at least three times its standard error in four instances, and 2·8 times in the fifth, and two relating to the height of the 9 and 16-year-olds are not significant. The difference in respect of the weight of the 16-year-olds (which alone favours 1952–53) is not of statistical significance.

These results, in conjunction with those arising from the comparison of the figures for 1953–54 with those for 1948–49, show unmistakably a continuance, among children of school age, of the upward trend in average heights and weights that has been a noteworthy feature of the past two decades.

(3) Regional Analysis: Mean Heights and Weights of Children aged 5, 9, 13, and 16 years, attending Scottish Education Authority Schools, Sessions 1951–52 and 1952–53.

A few years ago, a regional analysis of the average heights and weights of the children of the age groups customarily dealt with at systematic medical examinations gave somewhat anomalous results. This was due, it was believed, to the failure in certain areas, in the years immediately after the end of the recent war, to provide a proper system of checking the accuracy of the weighing machines and to make adequate provision for servicing them. Steps have been taken, however, by the authorities concerned to replace outmoded machines and to provide a regular system of checking and servicing, so that the results can now be accepted with a reasonable degree of assurance. This is so, despite the fact that, though the common practice, as in Edinburgh and Glasgow, is for the children to be weighed without shoes and wearing underpants (boys) or vests and knickers (girls), the children in certain areas wear slightly more clothing. Such a variation, however, does not invalidate the results for the country as a whole or for any of the six regions into which Scotland is divided for the purpose of the present analysis. The usual practice is to record the height to the nearest quarter of an inch, and the weight to the nearest quarter (or half) pound, using a steelyard weighing machine and fixed height-measuring equipment (in the absence of a height-measuring attachment to the machine). The height is taken with the child standing erect, back to the measuring rod, with the feet together and the weight on the heels and not on the toes or the outside of the feet.

A geographical-industrial grouping as been adopted for the regional analysis of the average heights and weights of the children aged 5, 9, 13, and 16 years. The six broad groups are as follows:

Region 1.—*Highlands*, comprising the northern and western counties, Aberdeen (excluding the city of Aberdeen), Argyll, Bute, Caithness, Inverness, Moray, Nairn, Orkney, Perth (and Kinross), Ross and Cromarty, Sutherland, and Zetland. Half of these are mainly rural areas, and the other half mainly consist of heath and moor.

Region 2.—*Eastern Counties*, comprising the counties of Angus (excluding Dundee), Banff, Clackmannan, Fife, and Kincardine. This region is predominantly rural, but has extensive fishing interests and, in the south-west of Fife, a considerable industrial and coal-mining population.

Region 3.—*Cities of Edinburgh, Aberdeen, and Dundee*. These urban districts are of a less industrial and more residential character than Region 6.

Region 4.—*Southern Counties*, comprising the lowland counties of Ayr, Berwick, Dumfries, East Lothian, Kirkcudbright, Midlothian (excluding Edinburgh), Peebles, Roxburgh, Selkirk, and Wigtown. Mainly rural, the region also contains many centres of light industry and, in Ayr, East Lothian, and Midlothian, extensive coal-mining interests.

Region 5.—*Western and Central Industrial Areas*, comprising the counties of Dunbarton, Lanark (excluding Glasgow), Renfrew, Stirling, and West Lothian. Primarily industrial—the heavy industries predominating, on balance—the region also contains a number of important coal-mining centres, and, as in Lanark and Stirling, extensive agricultural districts.

Region 6.—*City of Glasgow*. This is the most highly industrial of the four main cities of Scotland.

This grouping is on lines akin to those followed by Martin (1949) in his analysis of the medical examinations of 20-year-old Scotsmen registered under the Military Training Act, 1939, but there are a few important differences. Regions 1, 2, and 3 are more or less identical in both instances, but in the present article the region "Glasgow, Motherwell, Paisley" (representative of the more highly industrialized towns) is replaced by "Region 6, City of Glasgow" and "Region 7, Western and Central Industrial Area"; the counties of Dunbarton, Lanark, Stirling, and West Lothian are thus separated from the "Southern Counties" of the M.R.C. Memorandum.

In the present analysis a distinction is drawn between the children aged 5, 9, and 13 years on the one hand, and those aged 16 years on the other. Children aged 5, 9, and 13 years attending education authority schools constitute a high proportion of all the children of these age groups in each of the six regions (those at fee-paying schools independent of education authorities, for example, forming a very small proportion of the total), but the 16-year-old pupils at education authority schools do not form in any of the regions a representative cross-section of the children of that age group in the community.

Personal study of the particulars given on large numbers of medical record cards shows clearly that about two-thirds of the fathers of pupils who continue in attendance at secondary schools to the age of 16 years and beyond are in Social Classes I or II or in the more highly-skilled occupations of Social Class III.* This aspect of the subject needs no emphasis, as it has recently been dealt with at length by the Scottish Mental Survey Committee (Scottish Council for Research in Education, 1953) and the Central Advisory Council for Education (Ministry of Education, 1954). The essential point, for present purposes, is that, in arranging the six regions in descending order of average heights and weights, our prime concern is with the measurements of the 5, 9, and 13-year-olds.

Appendix Tables C and D show the average heights and weights of children of these three age groups for the two sessions 1951–52 and 1952–53, for each of the six regions as well as for Scotland as a whole. The actual average measurements have been adjusted to the uniform ages of $5\frac{4}{12}$, $9\frac{6}{12}$, and $13\frac{6}{12}$ years—the most convenient and appropriate in this instance—by use of the factors derived from a study of the measurements of children attending education authority schools in Edinburgh in session 1952–53.

The numbers dealt with are large, those for boys in Scotland as a whole totalling 44,936 at 5 years, 32,931 at 9 years, and 30,798 at 13 years in 1952–53, the corresponding totals for girls being 43,030, 31,828, and 30,108, respectively. In the six regions, the totals range for boys from 5,018 to 11,901 at 5 years, from 3,199 to 9,725 at 9 years, and from 3,161 to 8,454 at 13 years; the corresponding figures for girls are of like magnitude, and for them as for the boys, the lowest regional total for each age group is that for the Eastern Counties (Region 2), and the highest that for the Western and Central Industrial Area (Region 5).

* The five social classes are those into which occupations are customarily grouped in vital statistical investigations (General Register Office, 1951).

TABLE VI

SIX SCOTTISH REGIONS ARRANGED IN DESCENDING ORDER OF MEAN HEIGHTS AND WEIGHTS

Age (yrs)	5				9				13			
Measurement	Height		Weight		Height		Weight		Height		Weight	
Session	1951–2	1952–3	1951–2	1952–3	1951–2	1952–3	1951–2	1952–3	1951–2	1952–3	1951–2	1952–3
Boys	1	1	1	1	4	1	1	1	4	2	1	1
	4	2	4	4	1	4	4	4	1	4	4	4
	5	4	5	5	5	5	2	2	2	1	2	3
	2	5	3	2	2	2	5	5	3	3	5	5
	3	3	2	3	3	6	3	3	5	5	3	2
	6	6	6	6	6	3	6	6	6	6	6	6
Girls	4	1	1	1	1	1	1	1	2	4	4	1
	2	4	4	4	4	4	2	4	4	1	1	4
	1	5	2	2	2	2	4	2	1	5	2	3
	5	2	5	5	5	5	3	3	3	3	3	2
	3	3	3	3	3	3	5	5	5	2	5	5
	6	6	6	6	6	6	6	6	6	6	6	6

In Table VI the regions are arranged in descending order of average height and weight.

For boys, Region 1 (Highlands) and Region 4 (Southern Counties)—commonly in that order—almost invariably occupy the two top positions, and have the highest average values for both height and weight. Region 6 (Glasgow) occupies the lowest positions for height, with one exception, and weight, and Region 3 (Edinburgh, Aberdeen, and Dundee) most commonly occupies the second lowest position for both height and weight. Region 2 (Eastern Counties) and Region 5 (Western and Central Industrial Region) are intermediate, Region 2 being slightly superior to Region 5 in respect of height, while in weight, on balance, there is equality.

For girls, the pattern is practically identical. Regions 1 and 4 almost invariably have the highest average heights and weights—with Region 1 usually top, Region 6 invariably bottom, and Region 3 usually second to bottom. Here also Regions 2 and 5 occupy intermediate positions, with Region 2 usually above Region 5 in both height and weight.

Moreover, for each of the two sessions and for boys and girls alike, the order of the average weights of a particular age group is nearly always either identical with, or very close to, the order of the average heights.

As to the significance or otherwise of these various differences in average height and average weight, it is proposed to make seven sets of comparisons:

(*a*) *Comparison of All-Scotland Mean Heights and Weights, 1951-52 and 1952–53.*—Table VII summarizes the average heights and weights for Scotland as a whole for each of the two sessions, and shows the differences and the amount by which each exceeds its standard error.

TABLE VII

SCOTTISH EDUCATION AUTHORITY SCHOOLS
MEAN HEIGHTS AND WEIGHTS OF CHILDREN
AGED $5^{4}/_{12}$, $9^{4}/_{12}$, AND $13^{4}/_{12}$ YEARS
ALL-SCOTLAND MEANS, 1951–52 AND 1952–53

Age (yrs)		5		9		13	
Measurement		Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
Boys	1951–52	42·93	43·13	51·98	64·14	59·97	92·87
	1952–53	43·00	43·12	51·93	64·27	59·52	93·52
	Difference	0·07	0·01	0·05	0·13	0·05	0·65
	t =	5·7	0·3	2·8	1·9	1·8	4·7
Girls	1951–52	42·53	41·47	51·48	61·66	60·12	97·67
	1952–53	42·61	41·50	51·54	62·04	59·99	97·53
	Difference	0·08	0·03	0·06	0·38	0·13	0·14
	t =	6·2	0·9	2·7	5·0	5·5	1·0

Three of the six differences for boys are significant:

(*i*) the increase in average height at 5 years,
(*ii*) the increase in average weight at 13 years,
(*iii*) the fall in average height at 9 years.

Four of the six differences for girls are significant:

(*i*) the increase in average height at 5 years,
(*ii*) the increase in average height at 9 years,
(*iii*) the fall in average height at 13 years,
(*iv*) the increase in average weight at 9 years.

These facts, although in respect of two consecutive years only, provide additional evidence, on balance, that the upward trend in the average heights and weights of schoolchildren that has characterized the past two decades is continuing.

(*b*) *Comparison of Mean Heights and Weights for Individual Regions with those for Scotland as a Whole, 1951–52 and 1952–53.*—As an indication of the extent to which some of the average heights and weights for the individual regions differ from those

for Scotland as a whole, the range for each age group for 1952–53 is shown in Table VIII.

TABLE VIII

SCOTTISH EDUCATION AUTHORITY SCHOOLCHILDREN
REGIONAL ANALYSIS OF MEAN HEIGHTS AND WEIGHTS
RANGE OF MEASUREMENTS AT $5^{4}/_{12}$, $9^{4}/_{12}$, AND $13^{4}/_{12}$ YEARS
1952–53

Age (yrs)	Boys		Girls	
	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
5	42·48–43·53	42·07–44·59	42·16–43·09	40·54–43·07
9	51·26–52·51	62·59–66·75	50·90–52·47	60·73–64·44
13	59·15–60·21	91·11–98·21	59·51–60·56	95·20–100·37

The results for 1951–52 and 1952–53 are remarkably consistent for both girls and boys, for Regions 1 and 4 on the one hand, and Regions 6 and 3 on the other. There is justification for the conclusion that at 5, 9, and 13 years the average measurements of the children in Regions 1 and 4 are *above* the corresponding all-Scotland averages, the differences for boys being invariably, and those for girls almost invariably, of statistical significance:

Regions 1 and 4:

Boys: height, $t = 4{\cdot}5$ or more; weight, $t = 3{\cdot}5$ or more.

Girls: height, $t = 5{\cdot}5$ or more as a rule; weight, $t = 7{\cdot}3$ or more.

Moreover, at those ages, the average measurements of the children in Regions 6 and 3 are *below* the corresponding all-Scotland averages, the differences for Region 6 being invariably, and those for Region 3 almost invariably, of statistical significance:

Region 6:

Boys: height, $t = 12$ or more; weight, $t = 9{\cdot}9$ or more.

Girls: height, $t = 9{\cdot}7$ or more; weight, $t = 10$ or more.

(*c*) *Comparison of Mean Heights and Weights for Region 1 (Highlands) with those for Region 4 (Southern Counties), 1951–52 and 1952–53.*—An analysis, in terms of the significance or otherwise of the differences between the average heights and weights of the children of Region 1 and those of Region 4, at 5, 9, and 13 years, gives the following results:

Boys.—For the two sessions as a whole, there is a high proportion of differences which are not of statistical significance; the only significant differences common to both sessions are those at 5 years in respect of height ($t = 3{\cdot}2$ and $5{\cdot}4$), which favour Region 1 in each instance.

Girls.—There are four significant differences common to both sessions. For Region 1 there are significantly higher averages at 5 years in respect of weight ($t = 13$ and 11), and at 9 years in respect of both height ($t = 3$ and $7{\cdot}8$) and weight ($t = 6{\cdot}3$ and $5{\cdot}1$). Region 4 has significantly higher averages at 13 years in respect of height ($t = 3{\cdot}6$ and $7{\cdot}9$).

(*d*) *Comparison of Mean Heights and Weights for Regions 1 and 4 with those for Other Regions, 1951–52 and 1952–53.*—Attention is here confined to two points. First, there is a comparison, for each age group, of the average measurements for Regions 1 and 4 with the corresponding averages for the region providing the next highest average. Secondly, in the exceptional cases in which the average of the third region is higher than that of Region 1 and/or Region 4, there is the question of whether or not the difference is significant.

For boys and girls alike it is found that, when Region 1 and Region 4 present the highest and the second highest averages (as is usually the case, in respect of both height and weight), these averages almost invariably exceed to a significant extent the next highest corresponding average; when, exceptionally, the average for a region other than Region 1 or Region 4 is the highest for a particular age group, that average is most commonly not significantly greater than the corresponding averages for Regions 1 and 4.

(*e*) *Comparison of Mean Heights and Weights for Region 6 (Glasgow) with those for Region 3 (Edinburgh, Aberdeen, and Dundee), 1951–52 and 1952–53.*—The results of this analysis are as follows:

Height.—Over the two sessions as a whole, there are two instances only in which the averages for Region 6 exceed those for Region 3, namely, the averages in 1952–53 for boys aged 5 years (although the difference is not of statistical significance) and 9 years ($t = 5{\cdot}2$).

In the remaining four instances among boys, and in all six instances among girls, the average heights for Region 6 are significantly *below* those for Region 3 ($t = 4$ or more, except in one case).

Weight.—For both boys and girls, the averages for Region 6, for all three age groups in both sessions, are significantly *below* the corresponding averages for Region 3 ($t = 4{\cdot}7$ or more).

(*f*) *Comparison of Regions in Descending Order of Mean Heights and Weights with the Regional Order of Means for Young Adult Scotsmen examined under the Military Training Act, 1939.*—Brief reference has already been made to the Medical Research Council's memorandum (Martin, 1949) analysing the findings concerning 91,513 men aged 20 years (9,620 of them Scotsmen) who registered under the Military Training Act, 1939. The analysis was

restricted to those examined before the outbreak of war, and despite the absence of farm workers, the group represented not unfairly the young adult male population of the country at that time.

Table IX shows the main findings for the 9,620 20-year-old Scotsmen, the regions being arranged in descending order of average heights and weights.

TABLE IX

YOUNG ADULT SCOTSMEN REGISTERED UNDER MILITARY TRAINING ACT, 1939
MEAN HEIGHTS AND WEIGHTS, BY REGION

Region	Approx. No. Examined	Height (in.)			Weight (lb.)		
		Mean Height	±S.E.	S.D.	Mean Weight	±S.E.	S.D.
Highlands	510	67·8	±0·11	2·53	142·3	±0·75	17·03
Eastern Counties	1,070	67·3	±0·08	2·49	138·3	±0·48	15·79
Edinburgh, Aberdeen, and Dundee	1,570	67·1	±0·07	2·61	135·9	±0·38	15·08
Southern Counties	2,620	67·1	±0·05	2·55	135·7	±0·31	15·68
Glasgow, Motherwell, and Paisley	3,850	66·7	±0·04	2·65	133·1	±0·25	15·55
All Scotland	9,620	67·0	±0·03	2·61	135·3	±0·16	15·91

As Martin pointed out, the highlanders were on the average superior in physical measurements, the average height ranging from 0·4 to 1·1 in. and the average weight from 4·0 to 9·2 lb. above those of men from the other regions; men from the industrial centres of Glasgow, Motherwell, and Paisley, on the other hand, were inferior to those from the other regions in average height and weight, being, for example, 0·6 in. shorter and slightly more than 2½ lb. lighter than those from the two regions with the next smallest averages (namely, the Southern Counties—which in that investigation included several counties with highly industrial centres—and the cities of Edinburgh, Aberdeen, and Dundee).

The results of the particular part of the present investigation that is used for comparison with the above tally closely with the latter in respect of the regional order of average heights and weights. Region 1 (Highlands) with few exceptions, leads for both boys and girls in respect of height and weight at 5, 9, and 13 years, Region 4 (Southern Counties), another predominantly rural region, coming a close second. The amount by which the averages for Region 1 (Highlands) exceed the next highest averages is significant in nearly all instances (apart from those for Region 4). Similarly, the average heights and weights of children attending education authority schools in Region 6 (Glasgow) are significantly less than the corresponding figures for Region 3 (Edinburgh, Aberdeen, and Dundee), which has the next lowest averages.

(*g*) *Comparison of Mean Heights and Weights of Children aged 16 years attending Scottish Education Authority Secondary Schools in Individual Regions with those for Scotland as a Whole, 1951–52 and 1952–53.*—The total numbers of 16-year-old boys measured at systematic medical examinations in Scotland in sessions 1951–52 and 1952–53 were 2,697 and 2,902, the corresponding totals for the girls being 2,527 and 2,687. In Appendix Table E, the actual average measurements have been adjusted to the uniform age of $16\frac{7}{12}$ years, the factors employed being those based on the measurements of 16-year-old pupils attending Edinburgh education authority secondary schools during the three sessions 1951–52 to 1953–54.

Appendix Table E shows that the average measurements of the 16-year-olds in Scotland were:

Boys:
67·59 in. and 135·67 lb. (1951–52);
67·70 in. and 134·91 lb. (1952–53).
Girls:
63·66 in. and 123·64 lb. (1951–52);
63·66 in. and 123·57 lb (1952–53).

First, it should be observed that, although the average height of the 16-year-old boys for 1952–53 is above the corresponding average measurement for 1951–52, the difference is not significant; the average height of the 16-year-old girls is identical for the two sessions. The difference between the average weights for the two sessions, for both boys and girls, is not significant.

As has already been mentioned, the 16-year-olds do not form a representative cross-section of the children of that age group in any of the regions, as about two-thirds of the fathers are in Social Classes I or II or in the more highly-skilled occupations of Social Class III. From region to region they form a not dissimilar socio-economic group, and it is to be expected that the average heights and weights will be similar. In fact, relatively few of the average measurements for the individual regions are significantly above or below the corresponding all-Scotland averages; there are only two significant differences common to both sessions:

The average weight of the boys of Region 1 (Highlands) is significantly *above* that for Scotland as a whole ($t = 2·7$ and $3·0$), and the average height of the girls of Region 3 (Edinburgh, Aberdeen, and Dundee) is significantly *below* that for Scotland as a whole ($t = 2·5$ and $2·1$).

It is interesting to note a particular conclusion reached by Martin (1949): "It appears that Scotsmen to-day do not differ in stature from their fathers or their great-grandfathers." Morant (1950) showed that the average height of present-day recruits into the Royal Air Force does not increase after about 20 years, whereas that of recruits into the army in 1913 increased until 24 years of age. Clements and Pickett (1952), analysing a sample of medical records of the Ministry of Labour and National Service for the first quarter of 1941 for 3,700 Scotsmen (1,800 of them between 18 and 24 years of age), concluded that "Scotsmen of all social classes reach adult stature by the 19th year." These and many other investigators think that the faster growth among schoolchildren of the past 20 years and the earlier attainment of maximum mature height implies no increase in the final stature of young adults.

There have been relatively few attempts, especially in recent years, to compare directly the heights of a group of parents with three of their offspring, but Durnin and Weir (1952), in a comparison of the heights of groups of men and women students of the University of Glasgow with those of their parents, showed the men students to be 1·8 in. taller on an average than their fathers, and the women students to be 1·7 in. taller than their mothers. These results led to the conclusion that it was unlikely that these differences were wholly due to shrinkage of the parents, and that a real secular increase in height was at least a contributory factor. Moreoever, evidence recently furnished by Acheson and Hewitt (1954) in respect of nearly 600 pre-school children in Oxford lends support to the hypothesis of an increasing fulfilment of "growth potential", and thus of a net increase in the height of the adult population.

It is doubtful, however, whether a firm conclusion about this particular problem is possible, and the general question of the extent to which differences in stature (and body-weight) are determined by genetic or environmental factors is likely to remain controversial. It may well be, however, as Berry and Cowin (1954) presume, that "the answers to all those problems will ultimately be writ clear in the stature of future generations", partly as a result of the long-term research studies that are now afoot.

(4) Average Heights and Weights of the Schoolchildren of Four Highly Industrial Large Burghs compared with those of the Children of Four Less Industrial Large Burghs, at 5, 9, 13, and 16 Years, 1952–53.

In a sense this comparison is simply a variant of the preceding regional analysis. Just as the average heights and weights for children of the highly industrial city of Glasgow (Region 6) are significantly lower than the corresponding averages for the children of the less industrial Region 3 formed by the cities of Edinburgh, Aberdeen, and Dundee, so it is to be expected that the averages for the children of a group of industrial large burghs would be lower—possibly significantly so—than those for the children of a group of much less industrial large burghs.

To determine whether this was indeed so, the large burghs of Dumbarton, Falkirk, Kilmarnock, and Kirkcaldy were chosen for the highly industrial group, and the large burghs of Perth, Stirling, Ayr, and Dunfermline (three of these situated close to their "industrial" counterparts) for the less industrial group. The total number of children of the four age groups concerned who were measured during 1952–53 varied within each of the two groups of burghs from 1,300 to 2,500.

The particulars in Table X (overleaf) are drawn from Appendix Table F, the average heights and weights of both boys and girls having been adjusted to the uniform ages of $5\frac{4}{12}$, $9\frac{6}{12}$, $13\frac{6}{12}$, and $16\frac{7}{12}$ years, by use of the factors based on the recent measurements of children attending the Edinburgh education authority schools.

Analysis shows that at 5 and 9 years, for boys and girls alike, the average heights and weights of the children of the four highly industrial large burghs are significantly lower than the corresponding averages for the four less industrial large burghs. At 13 years the averages for the children of the highly industrial group are all lower than those for the children of the less industrial group, but in one instance only, the average height for girls, is the difference of statistical significance ($t = 7{\cdot}9$); at 16 years the averages for the children of the highly industrial group are lower, all the differences being significant except that relating to the average weight for girls.

It has to be noted, however, that, by the age of 13 years, in most of the eight burghs concerned, the "native-born" school population has been augmented to a variable extent by "migrants" from the county landward areas who are pursuing studies at secondary schools, and precise information is not available as to the number of those "migrants"; at 16 years of age also, there is continuance of this particular difficulty and, moreover, the total numbers are small.

The general trend, however, is interesting, and the findings in respect of the 5 and 9-year-olds, who are

TABLE X

EIGHT LARGE BURGHS, FOUR INDUSTRIAL AND FOUR NON-INDUSTRIAL
MEAN HEIGHTS AND WEIGHTS OF SCHOOL CHILDREN AT $5^{4}/_{12}$, $9^{6}/_{12}$, $13^{6}/_{12}$, and $16^{7}/_{12}$ YEARS
SESSION 1952–53

Age (yrs)		5		9		13		16	
Measurement		Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
Boys	Industrial Large Burghs	43·45	42·55	51·53	63·34	59·59	93·95	67·34	130·91
	"Non-industrial" Large Burghs	43·93	44·00	53·17	65·06	59·66	94·45	68·07	136·04
	Difference	0·48	1·45	1·74	1·72	0·07	0·50	0·73	5·13
	t =	7·1	8·8	16·0	4·6	0·5	0·7	2·5	8·8
Girls	Industrial Large Burghs	42·37	40·81	51·19	60·84	59·44	96·81	63·69	123·53
	"Non-Industrial" Large Burghs	42·93	41·55	52·65	62·73	60·31	97·72	64·44	124·06
	Difference	0·56	0·74	1·46	1·89	0·87	0·91	0·75	1·07
	t =	8·2	4·4	12·0	4·7	7·9	1·4	3·1	1·8

nearly all "native-born", are of importance for the present purpose, being in line with some of the main findings of the regional analysis on a geographical industrial grouping.

III. SUMMARY

(1) It is claimed that, although the increase in average heights and weights of children attending education authority schools in Edinburgh and Glasgow over the past 40 years may not be typical of Scotland as a whole, it illustrates the position in most of the populous industrial centres.

It is shown that the average measurements of children aged 5, 9, and 13 years in Edinburgh and Glasgow in session 1953–54 are all significantly greater than the corresponding averages for 1913–14. A few of these averages had already increased significantly by 1931–32, but the chief increases have occurred in steady annual increments during the past 20 years.

In 1913–14 the average measurements for the Edinburgh children at 5, 9, and 13 years were all above the corresponding averages for the Glasgow children. As time passed, most of these "gaps" were appreciably closed, but even so the present-day differences in favour of the Edinburgh children are statistically significant, with only one exception.

The proportionate increases in the average measurements of Glasgow boys and girls between 5 and 9 years, 9 and 13 years, and 5 and 13 years are closely similar for those born in 1925 and in subsequent years up to and including 1940.

(2) Edinburgh, Glasgow, Dundee, and Ayrshire together fairly represent the school population of the populous central industrial belt of Scotland. A study of the average measurements of schoolchildren aged 5, 9, 13, and 16 years for the 6-year period, 1948–49 to 1953–54, shows that by 1953–54 all the averages had risen, for boys and girls alike, the difference being significant in each instance. A comparison between 1952–53 and 1953–54 shows differences favouring the latter session in practically all cases, most of these differences being statistically significant.

Together, these results show a continuance of the upward trend in the average heights and weights of schoolchildren that has characterized the past two decades.

(3) The general situation throughout Scotland in regard to the weighing and measuring of schoolchildren at systematic medical examination is reviewed. In the subsequent analysis, the country is divided on a geographical-industrial basis into six regions:

Region 1, Highlands;
Region 2, Eastern Counties;
Region 3, Edinburgh, Aberdeen, and Dundee;
Region 4, Southern Counties;
Region 5, Western and Central Industrial Region (excluding Glasgow);
Region 6, Glasgow.

The average heights and weights of children aged 5, 9, 13, and 16 years attending education authority schools in sessions 1951–52 and 1952–53 are adjusted to the uniform ages of $5\frac{4}{12}$, $9\frac{6}{12}$, $13\frac{6}{12}$, and $6\frac{7}{12}$ years.

In the analysis a distinction is made between children aged 5, 9, and 13 years on the one hand and those aged 16 years on the other, as the 16-year-old secondary school pupils do not form a representative cross-section of the members of this age group in the community.

The all-Scotland averages for boys in session 1952–53 are:

43·00 in. and 43·12 lb. at 5 years.
51·93 in. and 64·27 lb. at 9 years.
59·52 in. and 93·52 lb. at 13 years.

The corresponding all-Scotland averages for girls in session 1952–53 are:

42·61 in. and 41·50 lb. at 5 years.
51·54 in. and 62·04 lb. at 9 years.
59·99 in. and 97·53 lb. at 13 years.

These average measurements, in comparison with their counterparts for 1951–52, provide additional evidence of a continuance of the upward trend in the average heights and weights of both boys and girls.

Arrangements of the regions in descending order of measurements brings out the following points:

(*i*) Region 1 (Highlands) and Region 4 (Southern) Counties)—commonly in that order—almost invariably have the highest average values for both height and weight for both boys and girls.

(*ii*) Region 6 (Glasgow) provides the lowest average heights, with one exception, and the lowest average weights, with Region 3 (Edinburgh, Aberdeen, and Dundee) most commonly providing the next lowest average measurements.

(*iii*) Region 2 (Eastern Counties) and Region 5 (Western and Central Industrial Region, excluding Glasgow) occupy intermediate positions, with the former, on balance, the more favourably situated.

(*iv*) For each of the two sessions, for both boys and girls, the order of average weights in a particular age group approximates closely, with few exceptions, to the order of the average heights.

(*v*) At 5, 9, and 13 years, the average measurements of children in the predominantly rural regions (1 and 4) are *above* the corresponding all-Scotland averages, the differences being almost invariably of statistical significance. In contrast, for each age group, the average measurements of children in the predominantly industrial regions (6 and 3) are *below* the corresponding all-Scotland averages, the differences being almost invariably significant.

(*vi*) The arrangement of the six regions in descending order of average heights and weights of children at 5, 9, and 13 years gives results that agree closely with the findings of Martin (1949) in an inquiry into the average heights and weights of young adult Scotsmen examined under the Military Training Act, 1939.

(*viii*) In the session 1952–53 the average measurements of the 2,902 16-year-old boys in attendance at education authority secondary schools throughout Scotland (measurements adjusted to the uniform age of $16\frac{7}{12}$ years) were 67·70 in. and 134·91 lb., and those of the 2,687 16-year-old girls were 63·66 in. and 123·57 lb. From region to region, so far as the occupations of the fathers are concerned, these 16-year-old pupils may be said to form a not dissimilar socio-economic group, of a level somewhat above that of the 16-year-olds in the community as a whole; in keeping with this, relatively few of the average measurements for the individual regions are significantly above or below the corresponding all-Scotland average.

(4) In addition to the regional analysis, the average measurements at 5, 9, 13, and 16 years of the schoolchildren of four highly industrial large burghs are compared with those of four less industrial large burghs. For both boys and girls, the average heights and weights in each age group in the highly industrial group of large burghs are below the corresponding averages for the less industrial group, most of the differences being statistically significant.

It is a pleasure to record my thanks to the medical officers of health and school medical officers throughout Scotland for their collaboration in checking the accuracy of the returns of heights and weights of schoolchildren for sessions 1951–52 and 1952–53; in particular, thanks are due to the medical, nursing, and clerical staffs of the school health departments in Edinburgh, Glasgow, Dundee, and Ayrshire for the careful recording, over the years, of the results of the systematic medical examinations.

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APPENDIX

TABLE A

CITIES OF EDINBURGH AND GLASGOW EDUCATION AUTHORITY SCHOOLS
SESSIONS 1913–14 TO 1953–54
AVERAGE HEIGHTS AND WEIGHTS OF CHILDREN OF 5, 9, AND 13 YEARS OF AGE EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION*

Age (yrs)			5		9		13	
City	Sex	School Session	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)	Height (in.)	Weight (lb.)
Edinburgh	Boys	1913–14	41·5	40·6	48·8	56·6	56·0	78·9
		1920–21	41·3	40·7	49·5	58·0	55·9	76·4
		1926–27	41·6	42·2	48·4	55·8	56·8	85·7
		1931–32	42·3	40·4	48·6	54·5	58·2	88·4
		1937–38	42·48	41·84	not available		not available	
		1949–50	42·61	42·78	51·59	64·04	58·96	91·37
		1953–54	42·79	42·67	51·72	64·05	59·57	93·27
	Girls	1913–14	41·2	39·6	48·7	55·7	59·0	84·3
		1920–21	40·0	39·1	49·2	55·8	56·9	79·1
		1926–27	40·5	39·3	48·9	53·5	55·6	82·7
		1931–32	41·3	39·0	48·7	53·2	59·6	92·5
		1937–38	42·12	40·34	not available		not available	
		1949–50	42·14	41·21	51·08	62·26	59·74	96·59
		1953–54	42·24	40·91	51·00	62·89	59·85	96·98
Glasgow	Boys	1913–14	40·5	37·7	47·4	54·8	55·1	76·4
		1920–21	40·2	39·5	49·1	54·4	54·7	74·8
		1926–27	40·9	39·3	49·5	56·4	56·1	78·8
		1931–32	41·1	39·4	49·3	57·0	56·3	79·8
		1937–38	41·65	40·52	50·23	59·45	57·33	83·45
		1949–50	42·47	42·31	51·08	61·84	58·60	88·43
		1953–54	42·43	42·05	51·40	63·16	59·01	90·93
	Girls	1913–14	40·4	37·0	48·3	54·1	56·3	79·0
		1920–21	39·8	38·1	48·3	53·5	56·5	78·5
		1926–27	40·7	38·1	48·8	54·3	56·5	82·1
		1931–32	40·7	37·8	49·1	55·0	57·3	83·7
		1937–38	41·34	39·01	49·98	57·59	58·47	88·93
		1949–50	42·00	40·46	50·54	59·64	59·22	93·16
		1953–54	42·04	40·69	50·83	61·08	59·48	95·41

* Measurements adjusted in 1937–38, 1949–50, and 1953–54 to the uniform ages of $5^{4}/_{12}$, $9^{4}/_{12}$, and $13^{4}/_{12}$ years. In earlier sessions the average ages at time of measurement approximated closely to these.

TABLE B

CITIES OF EDINBURGH, GLASGOW, AND DUNDEE, AND COUNTY OF AYR
EDUCATION AUTHORITY SCHOOLS—SESSIONS 1948–49 TO 1953–54
NUMBERS AND THE AVERAGE HEIGHTS AND WEIGHTS OF CHILDREN OF 5, 9, 13, AND 16 YEARS OF AGE EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION
ADJUSTED AVERAGE MEASUREMENTS (UNIFORM AGES OF $5^{4}/_{12}$, $9^{4}/_{12}$, $13^{4}/_{12}$, AND $16^{7}/_{12}$ YEARS RESPECTIVELY)

Age Group		Entrant Infants ($5^{4}/_{12}$ yrs)			Second Age Group ($9^{4}/_{12}$ yrs)			Third Age Group ($13^{4}/_{12}$ yrs)			Secondary Schools Age Group ($16^{7}/_{12}$ yrs)		
Sex	School Session	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)
Boys	1948–49	14,903	42·65	42·36	12,211	51·69	63·49	11,213	59·00	90·01	1,010	66·86	130·60
	1949–50	14,837	42·63	42·63	11,949	51·66	63·47	12,019	59·05	91·02	1,010	67·34	132·71
	1950–51	14,154	42·67	42·60	11,951	51·53	62·92	12·038	59·24	91·95	993	67·53	133·11
	1951–52	17,241	42·66	42·58	11,709	51·79	63·35	12,530	59·36	91·79	1,022	67·44	133·86
	1952–53	17,652	42·65	42·61	12,289	51·55	63·29	11,937	59·40	92·68	1,101	67·55	132·39
	1953–54	16,903	42·73	42·54	13,487	51·82	64·09	12,227	59·56	93·37	1,314	67·64	134·48
Girls	1948–49	14,177	42·19	40·69	11,423	51·05	60·72	11,289	59·35	94·22	782	63·49	121·24
	1949–50	14,143	42·19	40·97	11,778	51·08	61·32	12,226	59·59	92·12	707	63·54	121·68
	1950–51	13,409	42·29	41·05	11,575	51·13	61·29	12,198	59·62	95·65	801	63·36	123·21
	1951–52	16,774	42·32	40·91	11,779	51·14	61·34	12,594	59·95	97·50	907	63·67	123·63
	1952–53	17,197	42·34	40·96	11,487	51·30	61·60	11,578	59·84	96·72	925	63·64	122·70
	1953–54	15,960	42·48	41·10	13,170	51·34	62·45	12,604	59·96	97·37	1,150	63·63	122·81

TABLE C

BOYS ATTENDING SCOTTISH EDUCATION AUTHORITY SCHOOLS—SESSIONS 1951–52 and 1952–53
NUMBERS AND AVERAGE HEIGHTS AND WEIGHTS OF BOYS OF 5, 9, AND 13 YEARS OF AGE
EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION
ADJUSTED AVERAGE MEASUREMENTS (UNIFORM AGES OF 5 4/12, 9 6/12, AND 13 6/12 YEARS RESPECTIVELY)

Age Group		Entrant-Infants (5 4/12 yrs)			Second Age Group (9 6/12 yrs)			Third Age Group (13 6/12 yrs)		
School Session	Region	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)
1951–52	1. Highlands	4,761	43·38	44·58	3,911	52·24	66·42	3,440	59·84	95·33
	2. Eastern Counties	3,646	42·92	42·84	2,873	51·85	64·35	2,394	59·79	92·85
	3. Edinburgh, Aberdeen, and Dundee	6,214	42·61	42·93	4,666	51·89	63·68	5,075	59·59	92·18
	4. Southern Counties	6,446	43·27	43·77	4,874	52·55	65·45	4,626	60·16	95·14
	5. Western and Central Industrial Region (excluding Glasgow)	10,709	43·08	43·25	9,204	52·05	63·81	8,948	59·44	92·67
	6. Glasgow	9,297	42·49	42·02	5,969	51·39	62·35	6·535	59·07	90·57
	All Scotland	41,073	42·93	43·13	31,497	51·98	64·14	31,018	59·57	92·87
1952–53	1. Highlands	5,057	43·53	44·59	3,818	52·51	66·75	3,528	60·04	98·21
	2. Eastern Counties	5,018	43·46	42·85	3,199	51·79	64·20	3,161	60·21	92·51
	3. Edinburgh, Aberdeen, and Dundee	6,096	42·46	42·76	4,270	51·26	63·86	4,472	59·32	93·20
	4. Southern Counties	7,152	43·35	43·61	5,226	52·39	65·19	4,730	60·12	95·60
	5. Western and Central Industrial Region (excluding Glasgow)	11,901	43·04	43·32	9,723	52·10	64·15	8,454	59·22	92·77
	6. Glasgow	9,712	42·48	42·07	6,695	51·41	62·59	6,453	59·15	91·11
	All Scotland	44,936	43·00	43·12	32,931	51·93	64·27	30,798	59·52	93·52

TABLE D

GIRLS ATTENDING SCOTTISH EDUCATION AUTHORITY SCHOOLS—SESSIONS 1951–52, 1952–53
NUMBERS AND THE AVERAGE HEIGHTS AND WEIGHTS OF GIRLS OF 5, 9, AND 13 YEARS OF AGE
EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION
ADJUSTED AVERAGE MEASUREMENTS (UNIFORM AGES OF 5 4/12, 9 6/12 AND 13 6/12 YRS RESPECTIVELY)

Age Group		Entrant-Infants (5 4/12 yrs)			Second Age Group (9 6/12 yrs)			Third Age Group (13 6/12 yrs)		
School Session	Region	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)
1951–52	1. Highlands	4,533	42·79	43·31	3,869	52·03	64·06	3,481	60·26	99·40
	2. Eastern Counties	3,441	42·88	41·83	2,874	51·70	63·09	2,171	60·77	97·74
	3. Edinburgh, Aberdeen, and Dundee	5,918	42·33	41·05	4,776	51·34	62·12	5,054	60·15	97·59
	4. Southern Counties	6,077	42·90	42·06	4,708	51·72	62·77	4,534	60·49	101·00
	5. Western and Central Industrial Region (excluding Glasgow)	9,928	42·61	41·34	8,969	51·58	60·93	8,632	60·07	96·10
	6. Glasgow	9,148	42·07	40·44	5,798	50·80	60·22	6,636	59·48	95·03
	All Scotland	39,045	42·53	41·47	30,994	51·48	61·66	30,508	60·12	97·67
1952–53	1. Highlands	4,660	43·09	43·07	3,648	52·47	64·44	3,385	60·07	100·37
	2. Eastern Counties	4,863	42·69	41·61	3,278	51·48	62·43	3,145	59·93	97·02
	3. Edinburgh, Aberdeen, and Dundee	5,697	42·18	40·90	4,022	51·36	62·06	4,196	59·96	98·46
	4. Southern Counties	6,921	42·96	42·04	5,010	52·00	63·38	4,485	60·56	99·48
	5. Western and Central Industrial Region (excluding Glasgow)	11,261	42·76	41·58	9,678	51·46	61·16	8,487	59·99	96·84
	6. Glasgow	9,628	42·16	40·54	6,192	50·90	60·73	6,410	59·61	95·20
	All Scotland	43,030	42·61	41·50	31,828	51·54	62·04	30,108	59·99	97·53

TABLE E

PUPILS ATTENDING SCOTTISH EDUCATION AUTHORITY SECONDARY SCHOOLS—SESSIONS 1951–52, 1952–53
NUMBERS AND THE AVERAGE HEIGHTS AND WEIGHTS OF PUPILS OF 16 YEARS OF AGE EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION
ADJUSTED AVERAGE MEASUREMENTS (UNIFORM AGE OF 16 7/12 YRS)

Sex		Boys			Girls		
School Session	Region	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)
1951–52	1. Highlands	389	67·49	138·01	436	63·25	123·19
	2. Eastern Counties	235	67·25	137·01	191	63·66	122·82
	3. Edinburgh, Aberdeen, and Dundee	535	67·54	134·32	498	63·40	123·31
	4. Southern Counties	385	68·00	136·65	390	64·04	124·34
	5. Western and Central Industrial Region (excluding Glasgow)	709	67·70	135·27	654	63·78	123·57
	6. Glasgow	444	67·61	134·34	358	63·90	124·49
	All Scotland	2,697	67·59	135·67	2,527	63·66	123·64
1952–53	1. Highlands	403	67·28	137·84	500	63·57	125·24
	2. Eastern Counties	246	67·48	133·20	278	63·34	123·96
	3. Edinburgh, Aberdeen, and Dundee	450	67·74	132·18	436	63·38	122·17
	4. Southern Counties	431	67·90	134·94	429	63·53	125·13
	5. Western and Central Industrial Region (excluding Glasgow)	798	68·13	136·79	671	64·01	123·62
	6. Glasgow	574	67·28	133·23	373	63·87	121·56
	All Scotland	2,902	67·70	134·91	2,687	63·66	123·57

TABLE F

PUPILS ATTENDING EDUCATION AUTHORITY SCHOOLS—SESSION 1952–53, IN FOUR HIGHLY INDUSTRIAL AND FOUR LESS INDUSTRIAL LARGE BURGHS
NUMBERS AND THE AVERAGE HEIGHTS AND WEIGHTS OF PUPILS OF 5, 9, 13, AND 16 YEARS OF AGE EXAMINED IN SCHOOL DURING SYSTEMATIC MEDICAL INSPECTION
ADJUSTED AVERAGE MEASUREMENTS (UNIFORM AGES OF 5 4/12, 9 4/12, 13 4/12, AND 16 7/12 YRS RESPECTIVELY

Age Group		Entrant-Infants (5 4/12 yrs)			Second Age Group (9 4/12 yrs)			Third Age Group (13 4/12 yrs)			Secondary Schools Age Group (16 7/12 yrs)		
Sex	Burghs	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)	No. Examined	Height (in.)	Weight (lb.)
Boys	All eight burghs	2,892	43·69	43·27	2,104	52·41	64·22	2,561	59·56	94·20	322	67·74	133·74
	Four highly industrial burghs	1,464	43·45	42·55	1,036	51·53	63·34	1,289	59·59	93·95	145	67·34	130·91
	Other four burghs	1,428	43·93	44·00	1,068	53·27	65·06	1,272	59·66	94·45	177	68·07	136·04
Girls	All eight burghs	2,846	42·65	41·19	2,265	51·93	61·78	2,641	59·93	97·25	311	64·10	124·02
	Four highly industrial burghs	1,387	42·37	40·81	1,128	51·19	60·84	1,356	59·44	96·81	136	63·69	123·53
	Other four burghs	1,459	42·93	41·55	1,137	52·65	62·73	1,285	60·31	97·72	175	64·44	124·60

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EMPLOYMENT OF TUBERCULOUS PATIENTS

BY

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The results of a postal survey of the rehabilitation needs of recovered tuberculous patients living in Northern Ireland have been published recently (Barr, 1955). The present paper is concerned with the similar problem that exists for persons with quiescent disease.

Material

From a total of 7,068 tuberculous cases with quiescent or arrested disease (Ministry of Health, 1947) on the register of the Northern Ireland Tuberculosis Authority, 400 adults (*i.e.* persons 15 years of age and over) were selected at random. For 67* (16·8 per cent.) of these no data were forthcoming, but for 167 males and 166 females varying amounts of information were available. This group included 107 cases of early (A.1) pulmonary tuberculosis, 193 cases of more advanced pulmonary tuberculosis, and 33 cases of non-pulmonary disease.

Employment Status

The employment status of the sample members is shown in Table I.

TABLE I

ANALYSIS OF SAMPLE MEMBERS

Group	Male	Female	Total
Housewife Only	—	72	72
Housewife-Employee	—	10	10
Other Employed Persons ..	101	36	137
Unemployed Persons	66	48	114
Total	167	166	333

* Thirteen were living outside Northern Ireland, eight were lost sight of, three had been admitted to hospital, one was mentally defective, one was a seaman and was not at home at the time of the survey, and 41 refused to co-operate.

Counting housework as employment, 71·1 per cent. of the females were employed as compared with 60·5 per cent. of the males. The percentage employed for both sexes was 65·8.

Classification of Disease.—Using the Ministry of Health's classification (Ministry of Health, 1947), a comparison can be made between the early (A.1) and the more advanced (A.2, 3; B.1, 2, 3) cases of pulmonary tuberculosis (Table II).

The differences between the three groups of sample members in regard to classification of disease are significant at the 5 per cent. level of probability, the criterion adopted throughout. The greatest percentage of early cases occurred among housewives, while the highest percentage of more advanced pulmonary disease was found in the unemployed group. Ignoring the housewives, the value of χ^2 for the remainder is 4·82, which, for two degrees of freedom, gives a probability exceeding 5 per cent. Thus, the differences in classification between the employed and unemployed groups could easily have arisen by chance.

Occupation.—An analysis of the unemployed patients by occupation group showed that over 50 per cent. of the unemployed males and over 40 per cent. of the unemployed females were in Social Classes IV and V, almost a quarter of the unemployed males being labourers. In short, most of the unemployed patients were persons normally engaged in manual work.

TABLE II

DISTRIBUTION OF SAMPLE MEMBERS BY CLASSIFICATION OF DISEASE

Classification	No. of Sample Members				Percentage of Sample Members			
	Housewives	Employed	Unemployed	Total	Housewives	Employed	Unemployed	Total
Early Pulmonary (A.1) ..	35	46	26	107	42·7	33·6	22·8	32·1
Other Pulmonary ..	42	74	77	193	51·2	54·0	67·5	58·0
Other Sites (non-pulmonary) ..	5	17	11	33	6·1	12·4	9·7	9·9
Total	82	137	114	333	100	100	100	100

$\chi^2 = 10{\cdot}90$, $n = 4$, $0{\cdot}05 > P > 0{\cdot}02$

Fitness for Work.—It is difficult to give an exact estimate of the persons in this group who were fit for work, because a medical examination was not included as part of the survey, but the case-sheet of each unemployed patient was examined and the fitness for work at the last medical examination noted. 44 (38·6 per cent.) patients were unfit for any form of immediate employment, 52 (45·6 per cent.) were fit for work of some kind, and 18 (15·8 per cent.) had no specific records. Of the 52 patients classified as fit for work, 18 (34·7 per cent.) had been previously in work of a sedentary kind, 28 (53·8 per cent.) had been engaged in heavy industry, and six (11·5 per cent.) had been at school and had had no experience of employment.

Place of Residence (Table III).—No material differences were found between the employed and unemployed sample members living in:

(*a*) urban as against rural districts.

(*b*) Belfast as against provincial districts.

Education.—A slightly higher proportion of the employed patients had had a post-primary education, but the difference between this group and the remainder was small and not significant.

Type of Work Undertaken.—Assuming that the occupations in the Registrar-General's Social Classes (General Register Office, 1951) I, II, IIIc, IIId, and IIIe involve "light" work, and those in Social Classes IIIa, IIIb, IV, and V involve "heavy" work, a comparison may be made between the type of work undertaken before and after illness (Table IV).

Six persons (four males and two females) had no employment before diagnosis, and fifteen (seven males and eight females) who were in employment at the time of the survey had been at school before treatment was started. These persons are excluded from Table IV.

TABLE IV

DISTRIBUTION OF EMPLOYED SAMPLE MEMBERS BY TYPE OF WORK BEFORE AND AFTER ILLNESS

		Work before Illness		
		Heavy	Light	Total
Work after Illness	Heavy ..	19	9	28
	Light ..	9	79	88
	Total ..	28	88	116

Of the 28 persons in "heavy" employment before illness, nineteen (67·9 per cent.) returned to work of a similar kind, and nine (32·1 per cent.) found a lighter job. Of the eighteen persons formerly in the "light" employment group, 89·8 per cent. remained in this grade of work, and 10·2 per cent. changed to work of a heavier nature.

Prospects of Re-employment.—Some of the unemployed patients (35) were fortunate enough to have been employed by persons who were willing to make their previous job available when required, and a further nine had other prospects of securing congenial employment; hence, 44 (38·6 per cent.) of those unemployed had expectations of eventual employment. Of the seventy others, five were unemployable, three were too old to work, three were not anxious to work, five preferred to continue their education at special classes or at the University.

TABLE III

DISTRIBUTION OF QUIESCENT AND RECOVERED SAMPLE MEMBERS BY ADMINISTRATIVE AREAS

Sex	Area	Quiescent				Recovered			
		Housewives	Employed	Unemployed	Total	Housewives	Employed	Unemployed	Total
Male	Urban ..	—	70	38	108	—	27	16	43
	Rural ..	—	31	28	59	—	24	7	31
	Total ..	—	101	66	167	—	51	23	74
	Belfast ..	—	52	24	76	—	18	11	29
	Provincial ..	—	49	42	91	—	33	12	45
	Total ..	—	101	66	167	—	51	23	74
Female	Urban ..	59	27	36	122	40	12	6	58
	Rural ..	23	9	12	44	11	11	2	24
	Total ..	82	36	48	166	51	23	8	82
	Belfast ..	31	11	23	65	19	7	4	30
	Provincial ..	51	25	25	101	32	16	4	52
	Total ..	82	36	48	166	51	23	8	82

and 54 (47·4 per cent.) had no definite prospects of obtaining work. Of this 54, 22 were unfit for work at the time of the survey, 27 were able to undertake "light" work, and for five cases no details were available. Only twenty of the 52 patients who were fit for immediate employment had favourable prospects of securing work.

Registration as Unemployed.—27 patients (23·7 per cent.) were registered at the local employment exchange in the normal way, and 21 (19·4 per cent.) were registered under the Disabled Persons (Employment) Act (Northern Ireland), 1945. If the 52 fit for immediate work are considered separately, nineteen were registered in the usual way, and twelve were on the Disabled Persons Register. Thus, only 60 per cent. of those fit for work but unemployed were known at the unemployment bureau.

Housewives

Of the sample members interviewed, 82 were housewives, of whom ten had other employment and nine hoped to be able to return to industrial work. The mean age of housewives not employed (34·6 years) was greater than that of the housewife-employees (28·8 years). Practically all the housewives who undertook remunerative work lived in towns. In urban areas about one in three of the housewives combined housework with other employment, whereas in rural districts, the proportion was about one in twenty. In rural districts, however, the term "housewife" frequently includes extraneous tasks which, although not remunerated, should be regarded as additional employment.

The latest medical assessment showed that 64 were fit for light duties and twelve were not fit for any duties; in six cases no records were available.

The ten married women in paid employment worked 8·6 hours per day (outside the home) on five and a half days per week. Few of them had to travel more than 5 miles to work. Half of the group stated that their work had no ill-effects on them, while the others complained of exhaustion and tiredness.

Seven of the nine housewives who intended returning to work were able to do so if they wished, since their previous jobs were open to them, but in only one case did it appear absolutely essential for the housewife to find remunerative employment.

Comparison with Previous Survey of Recovered Patients

In the survey of recovered patients the percentage of males employed (68·9 per cent.) was slightly greater than that found in the present inquiry (60·5 per cent.); among the females there was a wider divergence, as 72·3 per cent. of the recovered females were employed as compared with 43·9 per cent. in the present survey. In the sample of recovered cases, 63·3 per cent. of the employed and 48·1 per cent. of the unemployed were early (A.1) cases, which may be compared with 38·3 per cent. employed and 25·9 per cent. unemployed early cases in this series. As far as employment and domicile were concerned, experience in the two surveys was similar (Table III).

The percentage of quiescent cases engaged in "heavy" work after illness (24·1 per cent.) is less than that found in the recovered survey (35·8 per cent.), but a drift of this kind—from "light" work immediately after treatment to "heavy" work after full recovery—is inevitable, unless sufficient and efficient re-training schemes are in operation. It can be postulated that between 25 and 35 per cent. of all patients will return to manual work.

The average size of family in the case of housewives with cured tuberculosis was 4·4 persons. Where the housewife combined house-keeping with other employment the family unit was somewhat smaller (3·0 persons). These figures resemble closely those found among quiescent cases. While the number of persons in the family did not differ substantially between the housewife-only and housewife-employee, there was a more marked difference in the number of children in the family. For the housewife-only in the present investigation, the mean number of children was 1·3, whereas in the other group it was 0·7. This finding lends support to the observation already made in the survey of recovered patients, that "the size of the family and the ability to procure domestic help are both important factors in determining whether or not a married woman seeks outside employment".

Summary

(1) A sample of four hundred quiescent cases was selected from 7,068 patients in Northern Ireland for the purpose of investigating the extent of employment. 67 failed to co-operate, leaving 333 patients about whom varying amounts of information were obtained. 137 (41·2 per cent.) were employed, 114 (34·2 per cent.) were unemployed, and 82 (24·6 per cent.) were housewives.

(2) Proportions of early and advanced cases employed were 63·9 and 49·0 per cent. respectively (housewives excluded).

(3) Of patients in "heavy" work before illness, 67·9 per cent. returned to work of a similar kind;

of those previously engaged in "light" work, 89·8 per cent. obtained similar employment.

(4) Over half of the unemployed males and over two-fifths of the unemployed females were in Social Classes IV and V. Almost one-quarter of the unemployed males were labourers.

(5) Of unemployed patients less than half were registered at the local Employment Exchange, and about half of those unemployed were thought fit for work. Of those fit for work 38 per cent. had immediate prospects of securing employment.

(6) About 12 per cent. of the housewives were gainfully employed.

(7) Differences between the size of the family in the housewife-only household and the housewife-employee household were not very great, except as regards the number of children.

(8) Several comparisons are made between the present investigation and a survey of recovered cases reported previously.

I should like to express my thanks to Miss A. Brown, Superintendent Health Visitor, and to the Health Visitors of the Northern Ireland Tuberculosis Authority for undertaking the field work connected with the survey. I am also indebted to Dr. E. A. Cheeseman, of the Department of Social and Preventive Medicine, the Queen's University, Belfast, for advice in planning the survey and to Miss P. Cole for typing the manuscript.

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OBSERVATIONS RELATED TO THE AETIOLOGY OF PLACENTA PRAEVIA

WITH SPECIAL REFERENCE TO THE INFLUENCE OF AGE AND PARITY

BY

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It is generally accepted that the frequency of placenta praevia is higher among multigravidae than among primigravidae. This observation has prompted the suggestion that low implantation of the ovum is a result of functional or structural changes in the uterus resulting from repeated pregnancies (Solomons and Canter, 1932; Davis and Campbell, 1946; Shaw, 1947; Findley, 1951). It is possible, however, that the association of placenta praevia with parity is secondary to its association with age, a result which would have different implications in respect of aetiology.

It is surprising that this possibility has received little attention. Penrose (1939) analysed a small series (72 cases) using a modification of the Greenwood-Yule method. He concluded that increasing maternal age is significant in central placenta praevia, and suggested that in non-central cases multiparity may be more important. These conclusions cannot be accepted unreservedly since a number of mothers had not reached the end of the reproductive period. Use of the Greenwood-Yule method in these circumstances is likely to give a false impression of the importance of increasing parity or maternal age. (This subject has received fuller consideration elsewhere—McKeown and Record, 1956). Kalmus (1946) compared a larger series (162 cases) with a random sample of hospital births and came to conclusions similar to those of Penrose. The control group was not entirely satisfactory, however, since hospital deliveries as a whole contain an abnormally high proportion of primiparae. No selection is applied to admission of cases of placenta praevia, which may therefore show an apparent association with multiparity.

It appears that a more reliable assessment of the relative importance of age and parity in placenta praevia would be useful, and that the suggestion that there is a sharp aetiological distinction between central and non-central types requires investigation. The present inquiry has been undertaken with this object. The method used was a comparison between a large series of cases of placenta praevia and a control group of births selected at random from the population in which the cases occurred. Also considered were the association with twinning and congenital malformations and the incidence of previous abortions and of ante-partum haemorrhage.

Material

An attempt was made to collect details of all cases of placenta praevia delivered in Birmingham during the years 1942–52 by inspecting the records of five maternity hospitals and two general hospitals containing large maternity units. For the years 1946–51 records appeared to be complete, but case notes in several of the smaller hospitals were not available for some of the other years. It is not likely that the omission of these cases has introduced any bias into the series since their number could not be large and there is no reason to suppose that they were unrepresentative. The data abstracted from the hospital records included patient's age, number and result of previous pregnancies, date of last menstrual period preceding relevant pregnancy, date of delivery, type of placenta praevia, and weight, condition, and fate of the foetus.

A control series of 1,156 births representative of all births to Birmingham residents during the years 1942–52 had been assembled for an earlier investigation (Smith and Record, 1955). The data included maternal age and number of previous pregnancies.

Results

Classification.—Assembling a series of cases of placenta praevia from a number of sources presents some difficulty on account of the diversity of systems of classification in common use. Much confusion may be caused by the use of the terms "lateral" and "marginal", which indicate the position of the

placenta relative to the lower segment in one system and to the internal os in another. Thus a low-lying placenta and a placenta praevia of intermediate type might be termed respectively "lateral" and "marginal" by one obstetrician, and "marginal" and "lateral" by another. Even in the same hospital the method of classification was not always uniform. The system most widely used was that advocated by Browne (1937) and with a slight modification it has been adopted in this inquiry. It was usually possible to assign cases described in other terms to the appropriate group of Browne's classification. In a few doubtful cases the less severe of the alternatives was chosen. Occasionally no classification could be made because the data were inadequate. No attempt was made to separate Types 3 and 4, since the distinction is a fine one and cannot be made with confidence unless the internal os is well dilated.

Records of 1,023 patients considered to have placenta praevia were obtained. Their classification according to type of disease is shown in Table I.

TABLE I

CASES OF PLACENTA PRAEVIA TREATED IN BIRMINGHAM HOSPITALS (1942–52)

Type of Placenta Praevia	Place of Residence				Total	
	In Birmingham		Outside Birmingham			
	No.	Per cent.	No.	Per cent.	No.	Per cent.
1 (placenta extends into lower segment) ..	294	39·3	107	38·9	401	39·2
2 (placenta extends to edge of internal os) ..	216	28·9	82	29·8	298	29·1
3 and 4 (placenta partially or completely covers internal os) ..	202	27·0	81	29·5	283	27·7
Unspecified	36	4·8	5	1·8	41	4·0
Total	748	100	275	100	1,023	100

INCIDENCE.—Estimation of incidence is based on the assumption that all patients with placenta praevia are admitted to hospital for delivery. Of the 1,023 cases, 275 who lived outside Birmingham came from an ill-defined area for which the total number of births could not be estimated. The remaining 748 were Birmingham residents and can be related to a known population of births. Since ascertainment was known to be incomplete for the years 1942–5 and for 1952, the estimate of incidence is based on 496 cases which occurred in the six years 1946–51. The total number of Birmingham confinements during this period is not precisely known since the Registrar-General records only the number of births (129,348 including stillbirths), but it can be estimated by assuming that one confinement in eighty results in twins. The number of confinements is thus presumed to be 127,751, giving an incidence of placenta praevia of 3·9 per 1,000. When applied to the relative frequencies given in Table I, this figure gives the incidence per 1,000 confinements as 1·6 for Type 1, 1·2 for Type 2, and 1·1 for Types 3 and 4.

The only previous attempt in recent years to estimate incidence of placenta praevia in a general population appears to be that of Hauch (cited by Davis, 1936) who obtained a value of 2·07 per 1,000 births in Denmark. Incidence among hospital confinements has been estimated many times. Figures vary considerably, ranging from 2·6 (per 1,000 deliveries) in a group of Stockholm hospitals (Westgren, 1954) to 11·9 in Siena (Rizzuti, 1947). These values, of course, reflect the extent to which domiciliary midwifery is practised in the area rather than the incidence of placenta praevia in the population.

RELATIVE INFLUENCE OF AGE AND PARITY.—Patients admitted to Birmingham hospitals who normally lived outside the city could not be related to a known population and are excluded from the examination of age and parity. Among Birmingham patients of known age and parity there were 289 cases of Type 1, 210 of Type 2, and 197 of Types 3 and 4. Cases of unspecified type were not used. Parity was calculated from the numbers of previous viable pregnancies, abortions being excluded.

By comparing the distribution by age and parity of the control group (Table II) with that of each type of placenta praevia, relative incidences in the various age-parity groups were obtained (Table III, opposite).

TABLE II

CONTROL GROUP DISTRIBUTED ACCORDING TO AGE AND PARITY

Age Group	Parity			All Parities
	1	2 and 3	4 and over	
Under 25	200	125	2	327
25–	126	187	42	355
30–	46	159	68	273
35 and over ..	25	79	97	201
All Ages	397	550	209	1,156

The significance of the trends was assessed by the method devised by Yates (1948).

In Type 1 placenta praevia, incidence appears to increase with both age and parity. When the trends are examined within fixed age and parity groups, the only significant ones are an increase with maternal age among primiparae, and an

TABLE III
RELATIVE INCIDENCE ACCORDING TO AGE AND PARITY

TYPE 1

Age Group	Parity 1	Parity 2 and 3	Parity 4 and over	All Parities	χ^2	*P*
Under 25–	0·7 (34)	0·7 (22)	— (2)	0·7 (58)	1·33	0·25
25–	0·6 (19)	1·0 (46)	2·0 (21)	1·0 (86)	10·70	0·001
30–	1·2 (14)	0·8 (30)	1·3 (22)	1·0 (66)	0·20	0·65
35 and over	2·1 (13)	1·1 (22)	1·8 (44)	1·6 (79)	0·13	0·72
All Ages	0·8 (80)	0·9 (120)	1·7 (89)	1·0* (289)	16·66	<0·0001
χ^2 ..	8·47	0·72	0·03	15·03		
P ..	0·004	0·40	0·86	0·0001		

* Age and parity unknown in five cases

TYPE 2

Age Group	Parity 1	Parity 2 and 3	Parity 4 and over	All Parities	χ^2	*P*
Under 25–	0·4 (15)	0·5 (11)	— (1)	0·5 (27)	0·33	0·57
25–	0·5 (12)	0·9 (29)	0·8 (6)	0·7 (47)	1·19	0·27
30–	1·2 (10)	1·4 (40)	1·2 (15)	1·3 (65)	0·002	>0·95
35 and over	1·8 (8)	2·5 (36)	1·5 (27)	1·9 (71)	0·93	0·33
All Ages	0·6 (45)	1·2 (116)	1·3 (49)	1·0† (210)	11·87	0·001
χ^2 ..	11·95	26·05	1·59	47·64		
P ..	0·001	<0·0001	0·21	<0·0001		

† Age and parity unknown in six cases

TYPES 3 and 4

Age Group	Parity 1	Parity 2 and 3	Parity 4 and over	All Parities	χ^2	*P*
Under 25–	0·2 (7)	0·4 (8)	— (1)	0·3 (16)	1·93	0·16
25–	0·7 (15)	0·8 (27)	1·0 (7)	0·8 (49)	0·55	0·46
30–	1·3 (10)	1·3 (36)	1·0 (12)	1·2 (58)	0·25	0·62
35 and over	2·3 (10)	1·9 (26)	2·3 (38)	2·2 (74)	0·005	>0·95
All Ages	0·6 (42)	1·0 (97)	1·6 (58)	1·0‡ (197)	19·79	<0·0001
χ^2 ..	28·16	19·05	5·23	64·23		
P ..	<0·0001	<0·0001	0·02	<0·0001		

‡ Age and parity unknown in five cases
Numbers of cases shown in brackets

increase with parity in women aged 25–29. In Type 2 and Types 3 and 4 the same association with both age and parity is exhibited by the totals. When attention is confined to fixed age and parity groups, incidence increases consistently with age but is unrelated to parity.

FERTILITY.—The report of a joint committee of the Royal College of Obstetricians and Gynaecologists and the British Paediatric Association on neonatal mortality and morbidity (1949) stated that the incidence of placenta praevia is thought to be relatively high in women who have had many pregnancies at short intervals. Eastman (1950) also mentions rapidity of child-bearing as a possible aetiological factor. No controlled study appears to have been attempted and the present inquiry provides only indirect evidence on this point. It seems reasonable to expect that, if patients with placenta praevia have had previous children at relatively short intervals, they would have attained a higher parity at a given age than normal mothers. In these circumstances there would be an association between incidence and parity when age is held constant. The fact that no such trend is revealed (except for Type 1 cases aged 25–29) suggests that the fertility of patients with placenta praevia is not abnormal.

INCIDENCE OF TWINNING.—There were nineteen twin pregnancies in the total series of 1,023 cases of placenta praevia. This incidence (1·86 per cent.) is greater than that in the general population (the frequency of twin maternities in England and Wales during 1938–48 was 1·22 per cent.: Waterhouse, 1950), but part of the difference can be explained by the fact that twinning is more likely at the ages when placenta praevia is most common. Standardization of the national rates quoted by Waterhouse to the age and parity distribution of the placenta praevia cases raises the frequency of twin maternities in the population to 1·35 per cent.; this frequency differs from that in the placenta praevia series by $0{\cdot}51 \pm 0{\cdot}37$ per cent. Although not significant this difference is not likely to be a chance occurrence since an increased frequency of twinning in placenta praevia has previously been recorded a number of times. This means, of course, that the incidence of placenta praevia is higher in twin than in single pregnancies. But this is probably not a matter of much aetiological importance; it may merely reflect the fact that in most twin gestations there are two placentae.

SEX RATIO.—Of the 1,042 infants in the series, sex was recorded for 1,004; 534 (53·19 per cent.) were males. The sex ratio of all births in England and

Wales for the same period was 51·54 per cent. Although the difference (1·65 ± 1·58) is too small to attract much attention, it is worth noting that Wesselink (1922) also found a raised sex ratio in placenta praevia (55·4 per cent. males in a series of 980). A possible explanation of this finding is considered below.

INCIDENCE OF MAJOR CONGENITAL MALFORMATIONS.—Malformations of the extremities, infantile pyloric stenosis, hernias, and naevi have been excluded from consideration. Records were complete for 1,004 infants; major malformations were noted in 22, in three of which two systems were involved. There were therefore 25 malformations in the series, giving an incidence of 2·49 per cent. (Table IV).

TABLE IV

INCIDENCE OF MAJOR CONGENITAL MALFORMATIONS

Type of Malformation	Number in 1,004 Cases of Placenta Praevia	Estimated Incidence in All Births (per 1,000)
Of central nervous system	12	6·94 (Record and McKeown, 1949)
Congenital heart disease	5	3·17 (MacMahon, McKeown and Record, 1953)
Exomphalos	3	0·31 (McKeown, MacMahon and Record, 1953)
Hare lip and/or Cleft palate	2	1·30 (MacMahon and McKeown, 1953)
Of genito-urinary tract	2	0·06 (Murphy, 1947)
Of gastro-intestinal tract (excluding pyloric stenosis)	0	0·44 (Murphy, 1947)
Mongolism	1	1·60 (Carter and MacCarthy, 1951)
Other	0	0·29 (Murphy, 1947)
Total	25	14·11

The incidence in all births was estimated (from published data relating to previous Birmingham inquiries combined with data from other sources) to be 1·41 per cent. Thus the excess of malformations in the placenta praevia series is 1·08 ± 0·37 per cent. This result supports the view of Greenhill (1923, 1939) that there is an association between placenta praevia and congenital malformations. The association is particularly marked in the case of anencephalus which accounted for seven of the 25 malformations in the present series (28 per cent.). The same percentage was shown by Greenhill's data (nineteen anencephalics in 67 malformations), and identical figures (nineteen in 67) were obtained by combining data from four other sources (Aigner, 1940; Macafee, 1945; Murphy, 1947; Tennent, 1947). Altogether, therefore, we have information on 159 malformations associated with placenta praevia; 45 (28·3 per cent.) of these were anencephalics. This percentage is 12·0 ± 2·9 in excess of the expected figure (16·3 per cent.) derived by relating the incidence of anencephalus in all births (2·3 per 1,000—Record and McKeown, 1949) to the estimated incidence of all major malformations (14·1 per 1,000).

This observation offers a possible explanation for the raised sex ratio of infants in cases of placenta praevia. It is well known that the sex ratio of anencephalus is low, and there is evidence that it is particularly low when pregnancy terminates unusually early (MacMahon and McKeown, 1952). When placenta praevia and anencephalus are associated, the pregnancy is likely to terminate early (for the six cases in which the data were available mean duration of gestation was 31 weeks). A number of foetuses, mainly female, may be lost at a stage when neither placenta praevia nor anencephalus is recognized. A series of cases of placenta praevia coming to medical attention may therefore be expected to show a slightly raised sex ratio.

INCIDENCE OF PREVIOUS ABORTIONS.—Adequate histories were available for 987 cases of placenta praevia (all types). These patients had had 1,994 previous pregnancies, of which 198 (9·9 per cent.) had aborted. It is not easy to find an acceptable control group with which this figure can be compared. The case notes of a consecutive series of 2,957 multigravidae delivered in the Birmingham Maternity Hospital recorded 1,044 abortions in 6,521 previous pregnancies. This incidence (16 per cent.) is likely to be greater than that in the general population since selection of cases for delivery in hospital is undoubtedly influenced by the previous obstetric history. A more satisfactory group for comparison, perhaps, is that derived from a survey of all births in the County Borough of Smethwick in the period April, 1949, to March, 1950. The results of previous pregnancies were recorded antenatally by an obstetrician or midwife, and data from 780 multigravidae were obtained. The total number of previous pregnancies was 1,640, of which 115 (7·0 per cent.) aborted. This is significantly less than the incidence in the previous pregnancies of patients with placenta praevia, but the difference (2·9 per cent.) is small. It seems reasonable to conclude that the present inquiry provides little support for the view of Binder (1934) that previous abortion is unusually common in patients with placenta praevia.

RECURRENCE.—Of the 987 patients with placenta praevia for whom reliable histories were available, ten reported placenta praevia in a previous pregnancy (five of these earlier cases are included in the present series). A history of previous antepartum haemorrhage of unspecified type was given by twelve patients, of whom two had had this complication twice. Excluding pregnancies which ended in abortion (198), the total number of previous pregnancies was 1,796. The incidence of placenta praevia in these pregnancies was therefore 0·56 per cent., and that of antepartum haemorrhage of unspecified type, in some cases almost certainly due to placenta praevia, was 0·78 per cent. Precise evaluation of risk of recurrence is not possible from these data, but it seems likely that women who have had placenta praevia are exposed in subsequent pregnancies to a risk somewhat greater than normal.

Part of this increased risk may be due to the fact that placenta praevia is now often treated by Caesarean section which, according to Bender (1954), may contribute to the likelihood of placenta praevia in a subsequent pregnancy. In the past, recurrence has rarely been reported. Fried and Torpin (1943) found only ten instances in the literature and added one further case. Irving (1936), reporting on 308 cases treated in the Boston Lying-In Hospital, found no instance of recurrence in the period 1916–34, but Aaberg (1946), working in the same hospital, recorded details of two recurrent cases. The fact that the present series which covers only an 11-year period contains five instances of recurrence within that period suggests that this phenomenon is becoming less rare. This may be due to the increasing frequency with which placenta praevia is treated by Caesarean section (Table V).

TABLE V

PERCENTAGE OF CASES OF PLACENTA PRAEVIA TREATED BY CAESAREAN SECTION

Year	Type				All Types
	1	2	3 and 4	Unspecified	
1942–	4·7 (43)	26·7 (30)	88·6 (35)	— (5)	38·9 (113)
1944–	15·1 (53)	26·8 (56)	77·8 (36)	— (3)	35·8 (148)
1946–	6·5 (93)	45·7 (81)	91·7 (72)	— (3)	44·6 (249)
1948–	18·8 (85)	54·5 (66)	91·8 (49)	— (7)	47·8 (207)
1950–52	40·4 (114)	48·1 (54)	95·1 (82)	— (20)	61·1 (270)
Total	20·1 (388)	42·5 (287)	90·5 (274)	63·2 (38)	47·8 (987)

Number of cases is given in brackets

It is perhaps worth recording the fact that four of the five patients who appear twice in this series and for whom detailed notes of the first incident are available were treated on both occasions by Caesarean section.

DISCUSSION

This inquiry provides strong evidence of the influence of age on the incidence of placenta praevia. The association is particularly striking in the more severe cases, but is by no means restricted to central placenta praevia; it is firmly established for Type 2 cases, and even Type 1 shows a significant trend with age among primiparae. Parity does not appear to play any part in aetiology except possibly in Type 1 cases occurring in women aged 25–29. Errors in diagnosis are more likely in the less severe forms of the disease, and it is quite possible that the group classified as Type 1 contains a number of cases of antepartum haemorrhage not due to a low-lying placenta. If this is so, this group does not constitute a clinical entity and therefore may be expected to show the age-parity pattern of placenta praevia superimposed upon that of one or more other conditions. The evidence does not support the view that central placenta praevia is aetiologically distinct from the non-central type (Penrose, 1939; Kalmus, 1947), and it seems doubtful whether parity is of much importance even in the least severe cases. It is therefore unlikely that elucidation of the cause of placenta praevia will result from a consideration of the influence of previous pregnancies on the structure or function of the uterus (except perhaps in the special case where a previous pregnancy was terminated by Caesarean section). A study of the influence of age on the uterus seems to offer a more promising approach.

SUMMARY

(1) During the years 1942–52, 1,023 cases of placenta praevia were treated in Birmingham hospitals. Incidence in the general population was estimated to be 3·9 per 1,000 confinements.

(2) The incidence of cases of Type 2 and of Types 3 and 4 showed an increase with advancing age within each parity group; there was no association with parity when age was held constant. Type 1 showed a significant trend with age among primiparae and with parity for mothers aged 25–29; it is suggested that this pattern may be due to inclusion of some cases of antepartum haemorrhage due to other causes.

(3) No special study of fertility was attempted, but the age-parity tables do not suggest any abnormality in this respect.

(4) The incidence of twinning was raised; this result is not unexpected and appears to be of little aetiological importance.

(5) Congenital malformations, especially anencephalus, occurred more frequently than usual. It is suggested that this observation may have some bearing on the slight excess of male foetuses in pregnancies complicated by placenta praevia.

(6) The abortion rate of previous pregnancies of patients with placenta praevia may be a little higher than that among mothers in the general population.

(7) The risk of recurrence appears to be greater than has hitherto been suspected. It is suggested that a possible factor is the increasing tendency to treat placenta praevia by Caesarean section.

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INVESTIGATION OF FOETAL MORTALITY ASSOCIATED WITH PLACENTA PRAEVIA

BY

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It is well known that a considerable part of the foetal mortality in placenta praevia is attributable to "prematurity", which is usually assessed on the basis of weight. The low weight is at least partly explained by the short gestation, but the possibility that it also results from retardation of foetal growth deserves attention. The decidua of the lower uterine segment is believed to be less vascular than that of the upper segment, and, although placentae attached to the lower segment are said to be larger than normal (Colmeiro-Laforet, 1953), it is not known whether this hypertrophy is sufficient to satisfy the demands of the foetus. In this communication we inquire to what extent low birth weight accounts for the high foetal mortality in placenta praevia and whether the low weight is wholly attributable to early delivery, or is also partly due to retardation of foetal growth.

The data assembled for this purpose also throw some light on the effect on foetal mortality of the modern tendency to adopt expectant methods of treatment. These methods were advocated by Macafee (1945) and Johnson (1945) in recognition of the high risk of foetal death associated with early delivery, and their observation that prolongation of pregnancy reduced the risks of the foetus without increasing those of the mother has been confirmed by others (Mills, 1948; Beilly, Greenberg, Aaron, and Peck, 1952). Examination of the influence of expectant treatment is complicated by the fact that during the last decade there have been other changes in the management of these cases. There has been an increasing tendency to treat placenta praevia, even the less severe types, by Caesarean section, and to avoid resort to hydrostatic bags, Willett's forceps, and version in cases delivered vaginally.

We have no information about the effect of changes in treatment on maternal mortality. The frequency of maternal death in placenta praevia is now so low that a very large series of cases would be required for this purpose.

MATERIAL

Sources of data are described in the preceding investigation of the association between incidence of placenta praevia and maternal age and parity. Briefly, information was sought about all cases delivered in Birmingham in the 11- year period 1942–52, by examination of the records of five maternity hospitals and two general hospitals. The only cases missed are believed to have been a small number before 1946 and in 1952 in some of the smaller hospitals, and there is no reason to suppose that their omission makes the series unrepresentative. Adequate data about control populations of births are available from earlier investigations in Birmingham, both of a large unselected series of hospital deliveries during several years, and of all deliveries in the city in one year (1947). For comparison of weight, the control group has been restricted to hospital births, since domiciliary weighings are less accurate. For investigation of duration of gestation and foetal mortality, the control group consisted of all Birmingham births in 1947, the mid-year of the period studied.

The number of cases for which data were available are shown according to type in Table I.

There were 971 single pregnancies, after exclusion of nineteen sets of twins and 33 single births for which information was very incomplete. Weight was known in respect of 873, and duration of gestation in respect of 837.

TABLE I

DETAILS OF 1,023 CASES OF PLACENTA PRAEVIA IDENTIFIED IN BIRMINGHAM HOSPITAL RECORDS 1942–52

Type of Placenta Praevia	1	2	3 and 4	Unspecified	Total
Total number of Cases	401	298	283	41	1,023
Cases with no Data	13	11	8	1	33
Twins	6	8	3	2	19
Single Births	382	279	272	38	971
Single Births of Known Weight	352	247	236	38	873
Single Births of Known Gestation	327	242	237	31	837

MORTALITY RELATED TO BIRTH WEIGHT

Among 971 cases of placenta praevia in single pregnancies delivered in Birmingham hospitals during the 11-year period, there were 144 stillbirths and 87 neonatal deaths in hospital of liveborn children. The mortality rate was 238 (stillbirths and neonatal deaths in hospital) per 1,000 total births. No strictly comparable figure is available for all

single births; among 22,454 single births in Birmingham during 1947 there were 39 stillbirths and neonatal deaths per 1,000 total births. The proportion of neonatal deaths which occur in hospital is high enough to make this experience acceptable for purposes of comparison.

The mean weight was 6·30 lb. for 873 births associated with placenta praevia, and 7·16 lb. for 13,020 Birmingham hospital single births (Table II). Differences in foetal weight associated with the different types of placenta praevia were trivial.

TABLE II

FOETAL WEIGHT IN PLACENTA PRAEVIA

Type of Placenta Praevia	No.	Mean Weight (lb.)	Difference between Means
1	352	6·33	0·18 ± 0·13
2	247	6·15	
3 and 4	236	6·32	0·17 ± 0·14
Unspecified	38	..	
Total	873	6·30	0·86 ± 0·04
All Hospital Single Births* ..	13,020	7·16	

* McKeown and Record (1953).

Mortality is of course greater for births associated with placenta praevia than for all single births, even when comparison is restricted to births of corresponding weight (Table III). As would be expected the difference is small in the case of births of low weight (under 4 lb.) for which mortality is very high. At all weights above 4 lb. mortality is much greater in placenta praevia, and the difference increases as weight increases.

We have attempted to assess the contribution of low birth weight to the total mortality in placenta praevia. The mortality rate based on 22,454 Birmingham births was standardized to correspond to the weight distribution of the 873 births associated with placenta praevia. By this procedure the mortality of all single births was raised from 39 to 118 (per 1,000 total births), which may be compared with the rate observed in cases of placenta praevia (238 per 1,000). This suggests that about half the increased mortality in placenta praevia is attributable to low birth weight.

Influence of Duration of Gestation and Rate of Foetal Growth on Birth Weight

We now inquire whether the low birth weight in placenta praevia is wholly attributable to early delivery or is due partly to retardation of foetal growth. Mean duration of gestation was 260·4 days for 837 cases of placenta praevia, and 280·5 for 17,072 single births in Birmingham during 1947 (Table IV). There was also a significant difference between Type 1 and Type 2, but not between Type 2 and Types 3 and 4.

TABLE IV

DURATION OF GESTATION IN PLACENTA PRAEVIA

Type of Placenta Praevia	No. of Foetuses	Mean Duration of Gestation (days)	Difference between Means
1	327	263·2	4·5 ± 1·9
2	242	258·7	0·5 ± 2·0
3 and 4	237	258·2	
Unspecified	31	..	
Total	837	260·4	20·1 ± 0·6
All Single Births in Birmingham, 1947*	17,072	280·5	

* Gibson and McKeown (1950).

The data in Table V (opposite) suggest that the low birth weight in placenta praevia is almost wholly attributable to the short period of gestation,

TABLE III

FOETAL MORTALITY RATES* ACCORDING TO BIRTH WEIGHT

Birth Weight (lb.)	Type of Placenta Praevia					All Single Births in Birmingham, 1947†	(a) ÷ (b)
	1	2	3 and 4	Unspecified	Total (a)	(b)	
Under 4	731 (26)	791 (24)	786 (14)	— (7)	732 (71)	723 (289)	1·01
4–	423 (26)	676 (34)	300 (30)	— (6)	458 (96)	242 (393)	1·89
5–	197 (61)	255 (51)	200 (45)	— (6)	209 (163)	93 (1,557)	2·25
6–	147 (102)	167 (54)	95 (63)	— (7)	137 (226)	30 (5,187)	4·57
7–	88 (91)	143 (56)	94 (64)	— (8)	100 (219)	21 (7,975)	4·76
8 and Over	65 (46)	143 (28)	50 (20)	— (4)	102 (98)	16 (7,053)	6·37
Unknown	300 (30)	406 (32)	444 (36)	— (0)	388 (98)	—	—
Total	202 (382)	319 (279)	213 (272)	184 (38)	238 (971)	39 (22,454)	5·29

No. of cases is given in brackets.
* No. of stillbirths and neonatal deaths in hospital per 1,000 total births.
† Gibson and McKeown (1951).

TABLE V

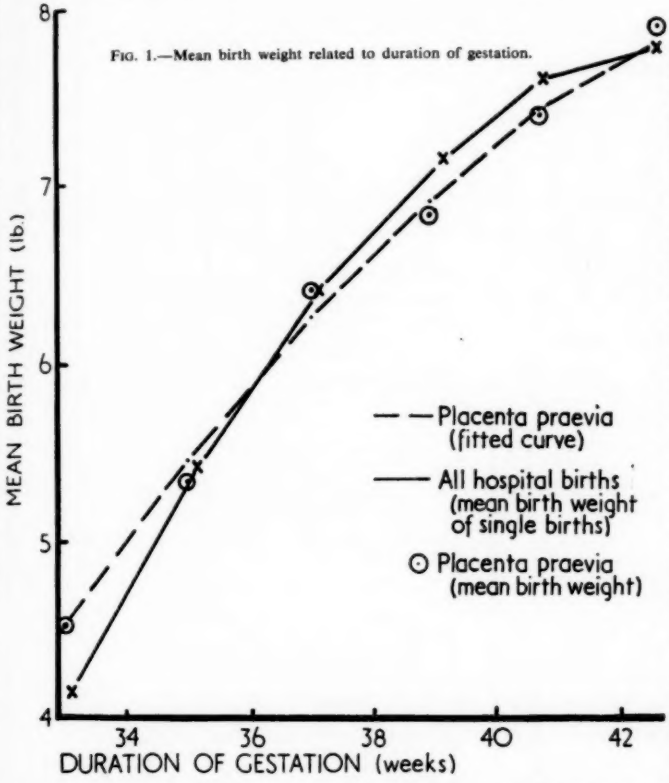
MEAN FOETAL WEIGHT ACCORDING TO DURATION OF GESTATION

Duration of Gestation (wks)	Placenta Praevia			Hospital Single Births*	
	No. of Foetuses	Mean Duration of Gestation (days)	Mean Foetal Weight (lb.)	Mean Duration of Gestation (days)	Mean Standardized Foetal Weight† (lb.)
32-	62	230·9	4·53	231·7	4·16
34-	90	244·9	5·33	246·0	5·42
36-	166	258·9	6·40	259·9	6·42
38-	222	272·6	6·82	274·2	7·14
40-	126	285·0	7·39	285·5	7·59
42-	37	298·5	7·88	298·3	7·76

* McKeown and Record (1953).

† Standardized to the distribution by sex and parity of the placenta praevia series.

FIG. 1.—Mean birth weight related to duration of gestation.



since at corresponding periods weight differences between foetuses associated with placenta praevia and hospital single births are small. For the purposes of this comparison, mean foetal weights of hospital births have been standardized to the distribution by sex and parity of the placenta praevia series. Cases of gestation of less than 32 weeks have been excluded since numbers are small. When the mean birth weights of the placenta praevia series are plotted, some irregularities are revealed. These can probably be ascribed to small numbers, particularly at the extremes of the distribution. A smooth curve of quadratic type, calculated by the method of least squares has therefore been fitted (Fig. 1). This suggests that growth of foetuses associated with placenta praevia is slightly retarded from about 37 weeks' gestation, but retardation does not appear to be sufficiently marked to have any considerable effect on birth weight. This conclusion is confirmed by the results of standardization to correct the mean foetal weights for differences in duration of gestation and parity (Table VI, overleaf). After this procedure the difference between mean weights of births associated with placenta praevia and all hospital single births is only 0·11 lb. After standardization there are no significant differences between mean weights of foetuses in the different types of placenta praevia.

It is concluded that foetal growth in placenta praevia is slightly retarded, but this accounts for only a small part of the difference in birth weight, which is mainly attributable to early delivery.

TABLE VI

MEAN FOETAL WEIGHTS STANDARDIZED* FOR DURATION OF GESTATION AND PARITY

Type of Placenta Praevia	No. of Foetuses	Standardized Mean Weight (lb.)	Difference between Means
1	285	6·47	0·03 ± 0·13
2	195	6·44	0·11 ± 0·14
3 and 4	194	6·55	
Unspecified	29	..	
Total	703	6·49	0·11 ± 0·05
All Hospital Single Births† ..	12,702	6·60	

* Means have been standardized to the distribution by gestation and parity of the complete placenta praevia series.
† McKeown and Record (1953).

SECULAR TREND OF FOETAL MORTALITY

Fig. 2 shows that there has been a fairly marked decline in foetal mortality (expressed as the number of stillbirths and neonatal deaths in hospital per 1,000 total births) during the 11-year period; it fell from 345 in 1942–3 to 181 in 1950–52. The improvement has been restricted to vaginal deliveries, but since this result is undoubtedly influenced by the type and proportion of cases selected for Caesarean delivery, not much significance can be attached to it. The fall in mortality has been marked in Types 1 and 2, but is not present in Types 3 and 4 (Fig. 3, opposite).

The data available enable us to explore two possible influences on the decline of mortality:

(*a*) greater use of expectant treatment;
(*b*) higher incidence of abdominal delivery.

It is clear that a strong association may be expected between foetal mortality and duration of gestation. The foetal mortality, in fact, shows a consistent fall with increasing gestation to 106 (per 1,000 total births) at 38–39 weeks (Table VII).

TABLE VII

FOETAL MORTALITY RATES ACCORDING TO DURATION OF GESTATION

Duration of Gestation (wks)	Type of Placenta Praevia				
	1	2	3 and 4	Unspecified	Total
Under 28	— (5)	— (2)	— (1)	— (0)	1,000 (8)
28– ..	471 (17)	591 (22)	846 (13)	— (1)	623 (53)
32– ..	328 (61)	439 (57)	358 (67)	— (9)	361 (194)
36– ..	159 (63)	204 (49)	129 (62)	— (10)	158 (184)
38– ..	82 (97)	157 (70)	91 (55)	— (5)	106 (227)
40– ..	143 (84)	190 (42)	77 (39)	— (6)	135 (171)
Unknown	255 (55)	541 (37)	171 (35)	— (7)	328 (134)
Total ..	202 (382)	319 (279)	213 (272)	184 (38)	238 (971)

No. of cases is given in brackets.

During the 11-year period there has been a conspicuous increase in the mean duration of pregnancies associated with placenta praevia (Table VIII), from 254·1 days in 1942–3 to 262·8 days in

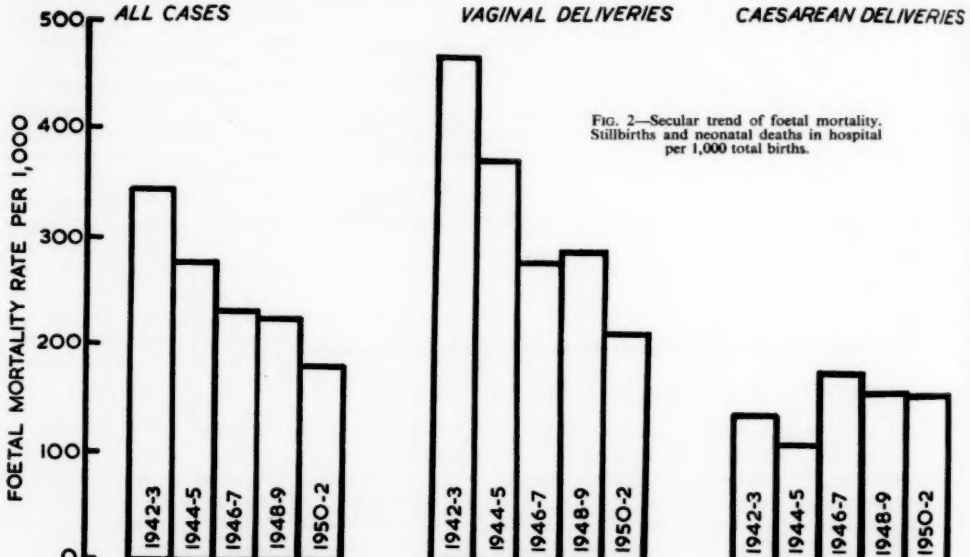


FIG. 2—Secular trend of foetal mortality. Stillbirths and neonatal deaths in hospital per 1,000 total births.

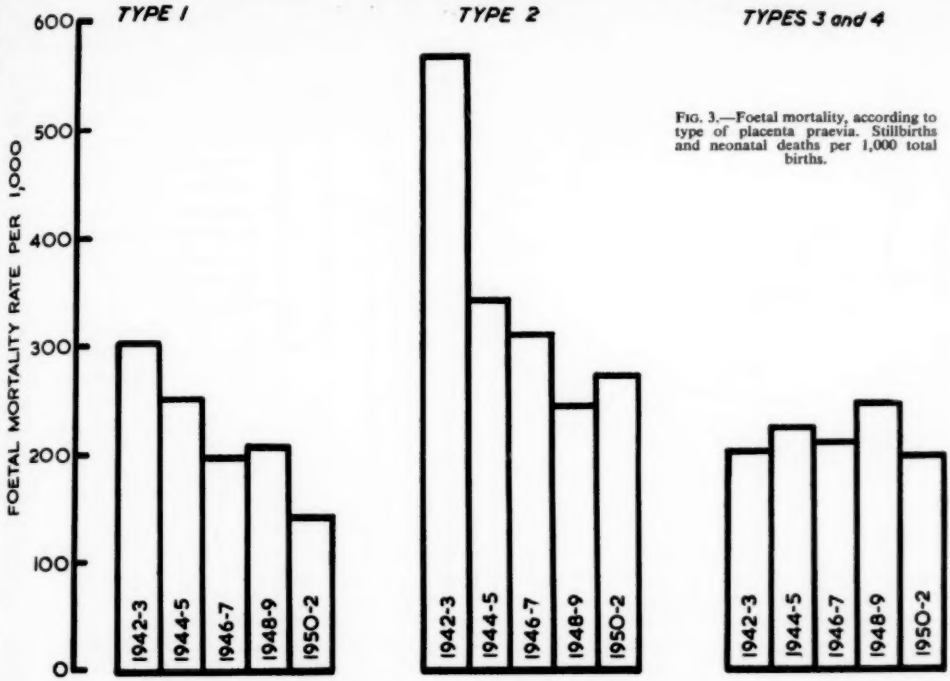


FIG. 3.—Foetal mortality, according to type of placenta praevia. Stillbirths and neonatal deaths per 1,000 total births.

1950–2. Since this result may be influenced by a changed distribution according to maternal age and parity, the mean has been standardized to correct for these variables. This correction has no substantial effect on the conclusion that the average length of pregnancy in cases of placenta praevia increased by about 9 days between 1942–3 and 1950–2 (see also Fig. 4). It seems unlikely that the whole increase can be attributed to expectant treatment, since it appears to have begun before 1945 (Table VIII) when expectant methods were not in general use.

TABLE VIII

SECULAR CHANGES IN DURATION OF PREGNANCIES ASSOCIATED WITH PLACENTA PRAEVIA

Year		1942–3	1944–5	1946–7	1948–9	1950–2
No. of Pregnancies		89	115	216	188	229
Duration of Pregnancy	Crude mean	254·1	258·2	259·5	262·7	262·8
	Mean standardized for maternal age and parity	254·9	258·2	259·4	262·8	263·5

During the period 1942–52 there has also been an increase in the proportion of abdominal deliveries (Fig. 4, overleaf). We have attempted to assess the relative contribution of these two changes—prolonged duration of gestation and increased use of Caesarean delivery—to the decline of foetal mortality. Table IX gives the crude death rates in 1942–7 and 1948–52, and shows the expected reduction in mortality resulting from the increase in abdominal deliveries, and the increased duration of gestation.

TABLE IX

ASSESSMENT OF CONTRIBUTION OF PROLONGED GESTATION AND METHOD OF DELIVERY TO DECLINE IN FOETAL MORTALITY

Year	1942–7	1948–52	Difference
Crude Foetal Mortality Rates	272	202	70
Applying 1942–52 rates to each series distributed according to mode of delivery	249	227	22
Applying 1942–52 rates to each series distributed according to duration of gestation	256	219	37

The results suggest that a little less than one-third of the reduction of foetal mortality can be accounted for by increased use of Caesarean delivery, and about one-half by the prolongation of gestation which has been brought about by expectant treatment. Almost

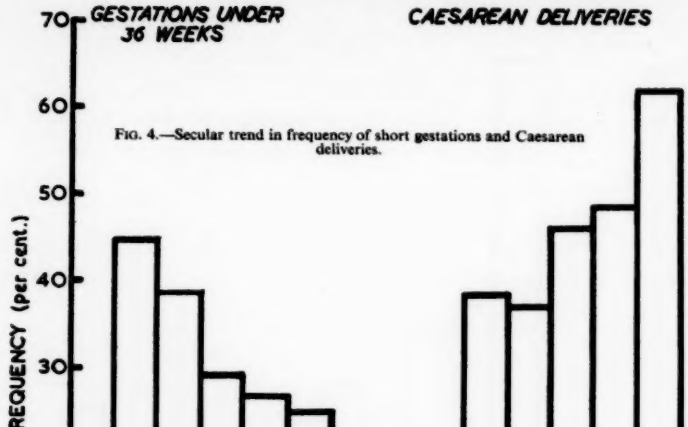


FIG. 4.—Secular trend in frequency of short gestations and Caesarean deliveries.

a quarter of the decline is not attributable to either procedure, and must be due to other influences, such as improved methods of vaginal delivery, and better care of the premature infant.

It may be recalled that Types 3 and 4 showed no decrease in foetal mortality during the period (Fig. 3). This is partly due to the fact that for a number of years it has been usual to treat these cases by Caesarean section (in 1942–3, 86 per cent. of cases were delivered in this way), so that the effect on foetal mortality of a further rise in the frequency of Caesarean section could not be large. But the increase in mean gestation of these cases (253·7 days in 1942–3 to 261·7 days in 1950–2) suggests that expectant treatment has been widely used and it is perhaps surprising that this has not resulted in a lower foetal mortality rate.

Investigation of duration of gestation in placenta praevia drew attention to an interesting association with mother's parity and age (Table X). Among women under 35, the mean period of gestation decreases with increasing parity, to an extent far greater than is observed in normal pregnancy. For example, for women under 25, the mean duration of gestation was 260 days for first births, and 248 for third and later births. The mean period of gestation also increases with age, an effect not observed in normal pregnancy.

The character of the distribution in Table X, however, suggests a social rather than a biological explanation of the association between length of gestation and maternal age and parity. In general, low parity at late ages, and high parity at early ages (represented by two corner cells in Table X) are characteristic of women in well-to-do and poor circumstances respectively. A distribution which changes progressively from one to the other of these extremes is highly suggestive of the influence of social circumstances. It is the distribution obtained by relating the proportion of women in poor circumstances (for example in the Registrar-General's Class V) to age and parity.

If this interpretation is correct, it suggests that duration of gestation in placenta praevia is related to the social circumstances of the mother. The implications of this conclusion are considered later, but before accepting it we must be assured that the results shown in Table X are not due to secular changes in the age-parity distribution. For example, the presence of an undue proportion of young mothers of high parity in the earlier years (when gestations were of shorter duration) could account for this pattern. This possibility was investigated by dividing the series into five groups according to year of delivery (1942–3, 1944–5, 1946–7, 1948–9, and 1950–2) and reconstructing Table X on the assumption that the age-parity distribution was the same in each group. This procedure had only a trivial effect on the result.

TABLE X

MEAN DURATION OF GESTATION (DAYS) IN PLACENTA PRAEVIA RELATED TO AGE AND PARITY

Age (yrs)	Parity		
	1	2	3 and over
Under 25	260 (67)	257 (32)	248 (11)
25–	265 (111)	259 (154)	256 (186)
35 and over	263 (44)	262 (59)	263 (173)

No. of cases is given in brackets.

Discussion

The contribution of low weight to foetal mortality, and of short gestation and rate of foetal growth to low weight in placenta praevia may perhaps be most readily appreciated by contrasting the results with those obtained in multiple pregnancy. In multiple pregnancy, low birth weight accounts mainly for the increased foetal mortality, since at corresponding weights there are relatively small differences in the death rates of single and multiple births (Record, Gibson, and McKeown, 1952). In placenta praevia, low birth weight accounts for only about 40 per cent. of the increased mortality, the remainder being attributable to other causes, such as asphyxia and haemorrhage, and, to a small extent, to a raised incidence of congenital malformations.

In multiple pregnancy the low birth weight is due partly to early onset of labour, and partly to retardation of foetal growth; the second influence is much more important than the first. In placenta praevia retardation of foetal growth is responsible for only a small part of the reduction of weight, which must be attributed mainly to short gestation. This observation underlines the importance of recent attempts to reduce mortality by expectant treatment which has as its objective the prolongation of pregnancy.

We have attempted to assess the contribution of expectant treatment to the reduction of foetal mortality. In Birmingham, during the 11-year period 1942–52, there has been a substantial decline in mortality, and it is estimated that about 50 per cent. of the improvement is due to prolongation of gestation, 30 per cent. to increased use of Caesarean delivery, and the remainder to other influences. Evidence is presented which suggests that the duration of pregnancy in placenta praevia varies according to the social circumstances of the mother, being substantially longer for well-to-do than for poor women. This observation is, perhaps, worth further consideration. Duration of gestation in placenta praevia depends on a number of factors, of which the most relevant are:

(*a*) The stage which the pregnancy has reached when the bleeding starts.

(*b*) The interval between the onset of bleeding and admission to hospital.

(*c*) The treatment adopted in hospital.

It is possible that all three are influenced by the social and economic circumstances of the patient. Women of low social class may bleed at an earlier stage than women with a similar type of placenta praevia living under good conditions. The initial bleeding may also be more severe or more persistent among women in poor circumstances, causing them to be admitted to hospital earlier. Having entered hospital, they may be unable to accept the expectant methods of treatment which might necessitate a prolonged stay. The data available from the present inquiry do not permit an exploration of these possibilities. The difference of 15 days between the mean duration of gestation of primiparae aged 35 and over and that of mothers of third and later children aged under 25 (263 and 248 days respectively) provides an indication of improvement which it may be possible to achieve.

Summary

(1) Data relating to 971 cases of placenta praevia occurring in single pregnancies treated in Birmingham hospitals in the years 1942–52 were analysed. The foetal mortality rate was 238 per 1,000. The rate for all Birmingham single births in 1947 was 39 per 1,000.

(2) Mean foetal weight was 6·30 lb. for births associated with placenta praevia and 7·16 lb. for Birmingham hospital single births. The low birth weight accounted for about half the increased foetal mortality in placenta praevia. It was mainly attributable to early delivery and only slightly to a retarded rate of foetal growth.

(3) During the period there was a substantial fall in foetal mortality (from 345 per 1,000 in 1942–3 to 181 per 1,000 in 1950–52). About one-half of this reduction was attributable to prolongation of gestation and a little less than one-third to increased use of Caesarean section.

(4) Examination of duration of gestation in relation to age and parity suggested that delivery occurred earlier among women in poor circumstances than among those living under better conditions.

We gratefully acknowledge our indebtedness to the staffs of the Birmingham maternity hospitals for permitting access to their records and to Miss Ida Giles and Miss Patricia Hobson for abstracting the data.

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SELECTION OF MINERS

A SURVEY OF SCHOOL-LEAVERS IN A VALLEY IN SOUTH WALES

BY

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Investigations carried out by this Unit have suggested that miners and ex-miners, whose chest radiographs show no pneumoconiosis, differ in physique and lung ventilatory function from men of comparable age in other occupations. Miners have usually been found to be shorter and lighter and to have a lower average ventilatory capacity than men who have never mined. Such differences are most marked in the 55–64 age group and are less in younger men. These differences may be due either to selection or to the mining environment. It is impossible to say if selection occurred in the past; but it is possible by comparing mining entrants with boys who take up other occupations to determine if it is occurring at the present time. In addition, it should be possible to find out if mining has any effect by comparing the two groups as they grow older.

In an attempt to answer some of these questions, an investigation of school-leavers in the Rhondda Fach Valley in South Wales has been started. We hoped that the initial examination of the boys, consisting in anthropometric and ventilatory capacity measurements, would answer the question of selection. We also proposed to follow the careers of these boys, repeating the various measurements periodically, in order to assess the influence of age, occupation, military training, and chronic respiratory disease on their development.

In addition to the physical and physiological examination, we also included a mental assessment using a short mental test (Dunsdon and Fraser Roberts, 1955).

The results of the initial study are now complete and it is possible to make some observations on the type of boy going into mining in the Rhondda Fach.

PROCEDURE

We decided to examine those boys living in the Rhondda Fach who left school at the end of the summer term, 1954.

Boys who live in the Rhondda Fach go to one of six schools: Ferndale Grammar, Ferndale Secondary, and Hendrefadog Secondary situated within the little Rhondda, and Porth Grammar, Rhondda County Grammar, and Islwyn Secondary situated outside the little Rhondda. There are thus three grammar schools and three secondary modern schools. In addition, a few boys receive a general education at the Rhondda Technical Institute in Llwynypia.

During the course of the Easter term, the headmasters of these schools were visited, the purpose of the investigation explained to them, and preliminary arrangements made. A list of the boys expected to leave at the end of the summer term was obtained. This list included dates of birth, addresses, and the occupations of the boys' fathers. A list of boys who were mentally or physically handicapped and who would in normal circumstances be leaving school at the end of the term was obtained from the Medical Officer of Health, Rhondda Urban District Council. There were eight of these, five physically and three mentally handicapped. On visiting their homes, it was found that five of the eight had already left school.

METHODS

ANTHROPOMETRIC MEASUREMENTS.—Standing and sitting height were recorded to the nearest half inch and weight to the nearest pound. The boys were wearing trousers and socks and a deduction of one pound was made for clothing. Bicondylar diameters of humerus and femur were measured to the nearest millimetre. Girths of the arm with the biceps maximally flexed and of the calf with the subject standing were measured at the widest point to the nearest $\frac{1}{4}''$. Three fat measurements, taken over the middle of the back of the arm, the right angle of the scapula, and the anterior abdominal wall 2″ above the

anterior superior iliac spine, were taken with Harpenden Skinfold Calipers (Edwards, Hammond, Healy, Tanner, and Whitehouse, 1955). These calipers maintain a constant pressure at all openings of the jaws. The pressure used in the present investigation was 7·5 g./mm². Bi-acromial and bi-iliac diameters and antero-posterior and transverse diameters of the chest were recorded with calipers to the nearest half centimetre.

PHYSIOLOGICAL MEASUREMENTS.—Ventilatory capacity was measured by recording the volume of air expelled during the first 0·75 second of a forced expiration, using a modified Gaensler (1951) apparatus. The mean of three or four readings was taken and the resulting volume is expressed as the (indirect) maximum voluntary ventilation (M.V.V.) as described by Kennedy (1953). A single vital capacity (V.C.) measurement was made, usually at the same time as the second or third timed volume measurement. Twenty boys from Ferndale Secondary School were examined on two occasions to determine the repeatability of the measurements.

RADIOGRAPHY.—*X* rays of the chest were taken of all boys, using a mobile *x*-ray van. Each boy had a full sized postero-anterior film and in addition a special "macro" film of the right side of the chest. Enlargement for this film was obtained by moving the subject towards the micro focus tube (focal spot 0·3 mm.) so that he was 24″ from the cassette, which was kept at the normal anode-film distance of 60″. A K.V. of 120 peak voltage and 1.8 milliampère-seconds was used with standard films and high voltage intensifying screens. Development was standard and automatic.

MENTAL TESTING.—The test used for intelligence grading was a combination of four already well-established verbal scales, all of which have been shown to have a high correlation with mental age (Terman and Merrill, 1937; Raven, 1938; Wechsler, 1949; Dunsdon and Fraser Roberts, 1953) and to intercorrelate with each other to the extent of from ·83 to ·87 (Dunsdon and Fraser Roberts, 1955). The combined scales, given orally and individually, provide a good measure for the rapid grading and comparison of large groups (Dunsdon and Fraser Roberts, 1955). The test has manifest advantages over other types of test in respect of reliability and validity (Terman and Merrill, 1937; Raven, 1938; Wechsler, 1949), relative elimination of coaching and practice effects, and applicability to subjects of all grades of intelligence and educational level.

At the beginning of the Michaelmas term, the schools were again visited, and those boys who had been examined as expected to leave were checked against those who had actually left. Any additional boys who had left unexpectedly were examined and *x*-rayed.

RESULTS

NUMBERS.—At the end of the summer term, 1954, 102 Rhondda Fach boys left school: 36 from grammar schools, 48 from secondary schools, and fifteen from the Rhondda Technical Institute. Three were mentally or physically handicapped boys who would have left school at this time in normal circumstances. The breakdown of these numbers according to age and school is given in Table I.

TABLE I
SCHOOL-LEAVERS (SUMMER, 1954)

School	Age (yrs)						Total Number of Boys
	14	15	16	17	18	19	
Porth Grammar	—	—	—	—	—	1	1
Rhondda County	—	4	2	1	2	—	9
Ferndale Grammar	1	6	2	6	10	1	26
Rhondda Technical	—	8	7	—	—	—	15
Islwyn Secondary Modern	5	6	—	—	—	—	11
Ferndale Secondary Modern	12	10	—	—	—	—	22
Hendrefadog Secondary Modern	7	8	—	—	—	—	15
Handicapped Boys	2	—	1	—	—	—	3
Total	27	42	12	7	12	2	102

REPEATABILITY.—It was found that the measurements were fairly repeatable. Table II shows the standard error of a single measurement, or where more appropriate (when measurements were made to the nearest ¼ or ½″) the percentage of subjects in whom there was agreement for the twenty boys on whom duplicate measurements were made.

TABLE II
REPEATABILITY OF MEASUREMENTS

Measurement	Repeatability
Standing height	Agreement in 60 per cent. of subjects, ¼″ difference in remainder
Sitting height	Agreement in 65 per cent. of subjects, ¼″ difference in remainder
Weight	S.E. 1·34 lb.
Vital capacity	0·1161 l.
Maximum voluntary ventilation (Indirect)	4·06 l./min.
Bicondylar diameter humerus	0·0694 cm.
Bicondylar diameter femur	0·0565 cm.
Girth of arm	Agreement in 70 per cent. of subjects, ¼″ difference in remainder
Girth of calf	Agreement in 55 per cent. of subjects, ¼″ difference in remainder
Fat over arm	S.E. 0·648 mm.
Fat over chest	0·660 mm.
Fat over abdomen	0·543 mm.
Bi-acromial diameter	0·500 cm.
Bi-iliac diameter	0·335 cm.
Transverse chest diameter	0·762 cm.
Antero-posterior chest diameter	0·426 cm.

MINERS.—Those boys who started at one of the two training centres for miners at Wattstown or Aberaman are considered to have taken up mining for the purpose of this analysis. An arbitrary definition is the only possible one. The group is likely to be a changing one; men who start training

may not complete it, and even if they complete it they may not necessarily enter the mines. Also boys who have first tried other jobs may finally enter mining. All that is really possible is to review the population at various times after they cease to be schoolboys. The present review was made after 3 months, when nineteen out of the 102 school-leavers had entered mining.

ANTHROPOMETRIC AND PHYSIOLOGICAL RESULTS.—Table III shows the mean values of height, weight, maximum voluntary ventilation, vital capacity, and mental test score, and Table IV the mean values of the other measurements in the 14, 15, and 16-year-old boys, according to whether they took up mining or some other occupation. It will be seen that of 27 boys aged 14 years, twelve took up mining and fifteen some other occupation. The mean ages in months of the two groups were close. The miners were slightly taller, the mean standing height being $\frac{1}{2}$" and the sitting height 1" greater, and they had a higher average M.V.V. and V.C., 8·5 l./min. and 0·34 l. greater respectively, than the others. None of these differences approach significance even at the 5 per cent. level. In the 15-year-old group, of which only six went into mining, statistically insignificant differences of 1·3 and 1·0" were obtained in the standing and sitting heights respectively. There was, however, a weight difference of nearly 16 lb. This difference in weight is statistically significant ($0·05 > P > 0·02$) and, if allowance is made for the slight differences in age of the boys in the two groups, the significance is enhanced ($0·01 > P > 0·001$). The larger bone and girth measurements in the miners combined with smaller skinfold thicknesses suggest that the difference in weight was due to bone and muscle development rather than to obesity.

The one 16-year-old who took up mining was 2·5" and 1·5" above the group means for the 16-year-olds, he was 40 lb. heavier, and his V.C. and M.V.V. were 1·54 l. and 11·0 l./min. larger.

Table V (opposite) shows the mean values by type of school. It will be seen that among the 15-year-olds the grammar and secondary schoolboys

TABLE III

MEAN VALUES FOR MAIN MEASUREMENTS AT EACH AGE ACCORDING TO OCCUPATION

Age Group	14-year-olds			15-year-olds			16-year-olds		
	Miners	Others	All Leavers	Miners	Others	All Leavers	Miners	Others	All Leavers
Number	12	15	27	6	36	42	1	11	12
Months since last birthday	10·8	10·5	10·6	1·3	3·7	3·3	1·0	3·2	3·2
Standing height (in.)	63·6	63·1	63·3	65·9	64·7	64·9	69·3	66·4	66·7
Sitting height (in.)	33·7	32·7	33·2	34·7	33·7	33·8	36·3	34·6	34·8
Weight (lb.)	109·7	109·3	109·5	126·5	110·7	112·9	176·0	127·5	131·5
Vital capacity (l.)	3·80	3·46	3·61	4·21	3·74	3·80	5·84	4·16	4·30
Maximum voluntary ventilation (l./min.)	118·8	110·3	114·1	126·3	117·1	118·4	152·0	140·1	141·1
Mental test score	66·2	61·2	63·3	73·2	76·9	76·3	91·0	95·2	95·1

TABLE IV

MEAN VALUES FOR ADDITIONAL ANTHROPOMETRIC MEASUREMENTS AT EACH AGE ACCORDING TO OCCUPATION

Age Group	14-year-olds			15-year-olds			16-year-olds		
	Miners	Others	All Leavers	Miners	Others	All Leavers	Miners	Others	All Leavers
Number	12	15	27	6	36	42	1	11	12
Bicondylar diameter humerus (cm.)	6·7	6·6	6·6	6·9	6·7	6·7	7·5	6·9	7·0
Bicondylar diameter femur (cm.)	9·3	9·3	9·3	9·7	9·3	9·4	10·1	9·5	9·5
Circumference of arm (in.)	10·2	10·0	10·1	10·9	9·9	10·0	13·3	10·8	11·0
Circumference of calf (in.)	12·5	12·6	12·5	13·5	12·5	12·7	15·3	13·4	13·6
Skinfold thickness over triceps (mm.)	8·3	10·1	9·3	8·5	9·4	9·2	16·0	9·2	9·8
Skinfold thickness over subscapular (mm.)	6·5	7·4	7·0	6·6	6·8	6·8	17·0	9·2	9·9
Skinfold thickness over abdomen (mm.)	4·9	6·0	5·5	4·5	5·5	5·4	11·0	6·3	6·7
Bi-acromial diameter (cm.)	34·3	34·7	34·5	36·7	34·4	34·8	40·5	36·8	37·1
Bi-iliac diameter (cm.)	25·0	24·9	25·0	25·9	25·1	25·2	27·0	26·2	26·3
Transverse diameter of chest (cm.)	24·7	24·6	24·6	26·1	24·4	24·6	31·0	26·6	27·0
Antero-posterior diameter of chest (cm.)	18·0	17·3	17·6	17·8	17·9	17·9	23·5	18·9	19·3

TABLE V

MEAN VALUES FOR DIFFERENT TYPES OF SCHOOL

	Type of School	Grammar	Secondary Modern	Technical	Mentally or Physically Handicapped	Total
15-year-olds	Number	10	24	8	—	42
	Months since last birthday	6·6	0·7	7·1	—	3·3
	Standing height (in.)	64·4	64·7	66·1	—	64·9
	Sitting height (in.)	33·7	33·5	34·6	—	33·8
	Weight (lb.)	111·5	111·5	119·0	—	113·0
	Vital capacity (l.)	3·65	3·73	4·20	—	3·80
	Maximum voluntary ventilation (l./min.)	113·5	116·8	129·5	—	118·4
	Mental test score	93·6	67·7	79·6	—	76·3
16-year-olds	Number	4	0	7	1	12
	Months since last birthday	3·0	—	3·3	3·0	3·2
	Standing height (in.)	68·3	—	66·3	62·8	66·7
	Sitting height (in.)	35·8	—	34·3	33·8	34·8
	Weight (lb.)	141·0	—	125·9	133·0	131·5
	Vital capacity (l.)	4·95	—	3·89	4·60	4·30
	Maximum voluntary ventilation (l./min.)	154·0	—	131·0	159·0	141·1
	Mental test score	96·0	—	85·1	91·0	89·3

were evenly matched, but that the boys from the technical college were on the average bigger and had larger ventilatory measurements. Among the 16-year-olds, however, the advantage was with the grammar school boys. There were no secondary modern schoolboys at this age for comparison.

MENTAL TESTS.—98 out of the 102 leavers were given the mental test. The mean scores of those in the 14 to 16-year-old groups are given in Table III.

The scores of boys (mainly from secondary modern schools) who entered mining were fairly randomly distributed among their colleagues. In the 14-year-old group, the mean score for boys entering mining was slightly higher and in the 15-year-old group slightly lower, than the mean group scores for those who left to enter other occupations. These mean score differences were however without statistical significance.

The one 16-year-old who took up mining obtained a score that was close to the mean for other leavers in his age group.

CHEST RADIOGRAPHY.—One boy was found to have an increase of the hilar shadow thought to be possibly due to tuberculous adenitis. He was referred to the Pontypridd Chest Clinic where a repeat *x* ray a few weeks later was reported normal. His Mantoux test was negative to 0·1 ml. 1 : 1000 old tuberculin. No radiological abnormality was found in any of the other boys.

The macro films, an innovation, were hard to read in view of our lack of any standard for comparison. Further work is in progress to compare these, presumably normal, films with those of men who have been exposed to dust and who show less than Category 1/- -/- simple pneumoconiosis.

SOCIAL FACTORS.—The occupations adopted by the leavers are shown in Table VI.

TABLE VI

OCCUPATIONS OF BOYS ON FIRST INQUIRY IN SEPTEMBER, 1954

Further Education	University	11	13
	Other	2	
Armed Services and Police	Army	2	7
	Royal Air Force	2	
	Awaiting call-up	3	
Industry and Commerce	Mining	19	61
	Apprenticed	11	
	Factory work	14	
	Locally in shops	12	
	Tailoring	3	
Clerk	Junior clerk on railway	2	4
	Bank clerk	1	
	Bookmaker's clerk	1	
Building Labourer			2
Warehouse or Storeroom Worker			2
Bar Attendant			1
Moved out of the Area			2
Unemployed			10
TOTAL			102

Each mining trainee was interviewed at the training centre and asked why he had taken up mining. The following reasons were given:

1. Family or friends in mining (including one boy whose "buddies told him it was nice"). This was the most frequent reason.
2. Tried other work and did not like it.
3. Tried to get other work and failed.
4. Money. Only one boy gave this reason.
5. One day off for study each week.

Information was available about the occupations and chest radiographs of the fathers of the school-leavers as a result of previous surveys of this valley (Cochrane, Cox, and Jarman, 1952, 1955). It is interesting to compare the proportion of miners among fathers and sons (Table VII). It will be seen that 3 months after leaving school, under 20 per cent. of the boys had taken up mining, compared with nearly 80 per cent. of their fathers. This difference may change with the passage of time as boys who have first tried other occupations become miners. It is interesting to observe that whether or not a boy took up mining was independent of the occupation of his father. The numbers that would be expected on a proportional basis are shown in Table VII in parentheses.

TABLE VII

FATHERS AND SONS IN MINING

Fathers' Occupation	Sons' Occupation				
	Mining		Other		Total
	No.	Expected	No.	Expected	No.
Mining	17	(15·3)	65	(66·7)	82
Other	2	(3·0)	14	(13·0)	16
Not known ..	0	(0·7)	4	(3·3)	4
Total	19		83		102

Classification of the chest *x* rays of those of the fathers who were miners is given in Table VIII. Unfortunately readings were not available for eight. Of the 33 fathers whose *x* rays showed no pneumoconiosis, nine sons (27·2 per cent.) took up mining, of the 41 fathers with pneumoconiosis, seven sons (17·1 per cent.) took up mining. Though this suggests that boys whose fathers have pneumoconiosis take up other occupations in preference to mining, the difference is not statistically significant.

TABLE VIII

CATEGORY OF PNEUMOCONIOSIS AMONG MINING FATHERS

Fathers' *X*-Ray Category of Pneumoconiosis	Sons' Occupation		
	Mining	Other	Total
None	9	24	33
Simple	4	20	24
Complicated	3	14	17
X ray not known ..	1	7	8
Total	17	65	82

DISCUSSION

The problem of past selection has been considered by various authors. D'Arcy Hart (1942) concluded that there was no difference in height and weight between normal miners and non-mining controls. His non-mining sample was however small and no allowance was made for age in the comparison. In the Ministry of Food Survey of 1943 (Kemsley, 1950), miners aged 15–19 years were found to be shorter and slightly lighter than other industrial workers in the same age group.

Investigations carried out at this Unit suggest that Rhondda Fach miners are smaller and lighter than men in other occupations of comparable age. For example in a detailed study of miners and age-balanced controls (Gilson, Hugh-Jones, Oldham, and Meade, 1955), it was found that on the average miners without pneumoconiosis were over 1" shorter and between 7 and 15 lb. lighter, in each of three age groups, than men who had never mined. Differences were also observed in the ventilatory capacities: the maximum breathing capacity was 10 to 24 l./min. and the vital capacity 0·34 to 0·83 l. less in the mining groups. In a more recent investigation of a random sample of miners, ex-miners, and non-miners carried out in the Rhondda Fach, differences in stem height and weight were observed in the 55 to 64-year-old group, but not in the 25 to 34-year-old men. Ventilatory capacity measurements on the other hand were lower in the miners than in the non-miners in both age groups, but the difference was more striking in the older men. The anthropometric differences were not confirmed in a random sample of men aged 55 to 64 in Leigh in Lancashire, and they may therefore be characteristic of the Rhondda Fach. Significantly lower ventilatory capacity measurements were however found in Leigh in miners compared with men who had never mined.

In the present investigation the boys who took up mining were not smaller, lighter, or physiologically less able than those who took up other occupations. The results suggest that, on the contrary, although other social factors are undoubtedly also involved in the choice of occupation, the bigger and more muscular boys are more likely to take up mining. It should, however, be mentioned that this difference could be due to the mining boys being more advanced in adolescence.

The differences that have been observed in previous surveys may have been due to past selection. Certainly alternative occupations were far fewer in the time of the fathers of the present group, as is well shown from the different proportion of the elder men who became miners,

approximately 80 per cent. compared with 19 per cent. On the other hand it is possible that environmental factors may have been responsible, partially if not wholly. The follow-up of these boys should provide valuable information on this point.

MENTAL TEST.—Norms for the combined tests, permitting the elimination of age differences, are not available beyond the age of 15 years. Raw scores can however be used in this particular survey because:

1. Comparisons are made in year groups.
2. Within these groups, the differences in mean age at test, between those entering mining and the remainder of leavers, are small.
3. Differences in average performance within groups are small.

Among the boys in the 14-year-old group, who had left school as soon as they were legally entitled to do so, the mining entrants appeared to have a slight intellectual advantage over other leavers of comparable age. The mean score difference of five words (Table III) was not however significant ($t = 0{\cdot}8958$; $0{\cdot}4 > P > 0{\cdot}3$). The miners were, however, on average 1·5 months younger than the other leavers. At age 15 years exactly, this would correspond to 0·8 word; the score difference should therefore be increased by something of this order. Even making this adjustment for age which would slightly widen the gap, the difference is well below the 5 per cent. level of significance.

In the 15-year-old group, the mean score for miners was slightly below that for other leavers, but the difference was even less than that found in the 14-year-old group. In the 15-year-old group, the non-miners are at an average disadvantage of 3·73 words. The miners are 2·3 months younger than the other leavers, and so, using the same regression as before, the difference should be adjusted to 4·9 words. This difference is far below the 5 per cent. level of significance.

Any comparison of miners with other leavers according to type of school attended is possible only for boys in the 15-year-old group, since none but secondary school leavers were in the 14-year-old group and, among the 16-year-old leavers, only one handicapped boy had left from a secondary school. Mean scores for all mining and other leavers in the 15-year-old group are given according to school in Table IX. From this it may be seen that the test differentiated quite well between the secondary modern school boys and those of comparable age who had left from other types of schools. Numbers are too small, however, to allow the statistical significance of the differences to be given except as between secondary modern boys and those from technical and grammar schools combined. The difference in this case is highly significant ($P > {\cdot}001$).

TABLE IX

MENTAL TEST MEAN SCORES (15-YEAR-OLD GROUP)

Type of School	Leavers		
	Miners	Others	All
Secondary	72·50	66·68	67·70
Technical	74·50	81·33	79·63
Grammar	—	93·60	93·60
All .. .. ..*	73·17	76·88	76·34

CONCLUSIONS

Whatever the reason for the differences in anthropometric and physiological measurements between miners and ex-miners and men who had never worked in the mines which have been recorded previously at this Unit, the present investigation offers no evidence that selection of miners in favour of the boys who are smaller, lighter, and less physiologically able is occurring now. On the contrary, this investigation suggests that there is a tendency for the bigger and more muscular boys with larger ventilatory capacities to go into the pits. That this is a subjective reason and that there are other more consciously obvious directives, such as relatives or friends in the job, money, or lack of suitable alternatives, is probable from the answers obtained to the question why the boys took up mining.

The intelligence of the mining entrants was not significantly different from that of other leavers of comparable age in the area studied.

SUMMARY

An investigation has been carried out into the problem of selection for mining.

School-leavers living in the Rhondda Fach have been examined anthropometrically, physiologically, and mentally to determine if those who take up mining differ from the rest of the population.

Mean heights, weights, M.V.V., and V.C. were larger in the mining groups at each of three ages. These differences were not significant, except in the case of weight in the 15-year-old group, which was significant at the 5 per cent. level ($·05 > P > ·02$). This difference of weight appeared to be due to the greater bone and muscle development in the miners.

The mental ability of the boys taking up mining was average for boys from secondary modern schools in the area.

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SOCIAL MEDICINE STUDIES BASED ON CIVILIAN MEDICAL BOARD RECORDS

V. PHYSICAL AND OCCUPATIONAL CHARACTERISTICS OF MEN WITH HERNIA, SPINAL CURVATURE, AND RHEUMATISM

BY

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In previous papers we have discussed the following conditions recorded by Civilian Medical Boards: all causes of rejection from military service; varicosities; skin diseases; digestive disorders; and foot defects (Stewart, Webb, and Hewitt, 1955, a, b, c, d; Hewitt, Stewart, and Webb, 1953). On this occasion we shall be considering three disease groups which have little in common except that they have an obscure aetiology and were recorded sufficiently often to merit statistical analysis: namely, hernia, spinal curvature, and rheumatism. The basic material and methods of analysis remain unchanged (Stewart and others, 1955b) and wherever comparisons are made in terms of Standardized Prevalence Ratios (S.P.Rs) they incorporate an allowance both for regional variation in standards of recording (Essex, Northamptonshire, and Leicester) and for differences in age distribution.

HERNIA.—After all cases were excluded in which the record suggested that the condition had been present since childhood, there were 2,122 men who had an inguinal or a femoral hernia at the time of examination or an operation scar in the appropriate place (Table I). After differences of age distribution had been allowed for, it was found that the recorded prevalence in the three regions lay within 2 per cent. of the rate for all regions combined. This unusually close agreement suggests that, for hernia at least, Civilian Medical Board records may provide a reasonably accurate measure both of general prevalence and of current incidence at various ages. Judging from the present data, the annual incidence for males remains fairly constant between the ages of 17 and 45 and is in the region of 0·4 per cent. per annum.

Members of Social Classes I and II (largely identical with the professional and administrative workers of Table III, overleaf) had 20 per cent. less than their "standard" number of cases, and clerical (mainly Social Class III) also had a significantly low S.P.R. (Tables II and III). Otherwise there was no evidence of a relationship either between hernia

TABLE I

NUMBERS OF CASES AND CRUDE PREVALENCE RATES PER 1,000 AMONG MEN EXAMINED AT THREE CIVILIAN MEDICAL BOARD CENTRES (1941–44)

Disability		Leicester	North-ampton	Essex	Total
Hernia	Number	1,036	594	492	2,122
	Rate	44·6	37·7	41·1	41·7
Spinal Curvature	Number	757	163	345	1,265
	Rate	32·6	10·3	28·8	24·8
Rheumatic Fever (all cases)	Number	840	574	482	1,906
	Rate	36·7	36·4	40·3	37·4
Rheumatic Carditis	Number	236	252	110	598
	Rate	10·2	16·0	9·2	11·7
Other Rheumatic Fever	Number	614	322	372	1,308
	Rate	26·5	20·4	31·1	25·7
Non-Specific Rheumatism	Number	410	330	563	1,303
	Rate	17·7	20·9	47·0	25·6

TABLE II

COMPARATIVE PREVALENCE BY SOCIAL CLASS

Social Class	Standardized Prevalence Ratios				
	Hernia	Spinal Curva-ture	Rheu-matic Carditis	Other Rheu-matic Fever	Non-Specific Rheu-matism
I and II	80	68	100	114	99
III	104	103	100	99	100
IV	96	106	110	86	103
V	103	107	92	105	99
Value of χ^2 for 3 d.f.	12·304	15·178	1·208	6·572	0·187
P (χ^2)	0·01–0·001	0·01–0·001	0·80–0·70	0·10–0·05	0·98–0·95

* In receipt of a grant from the Medical Research Council

and economic status or between hernia and occupation. Since the groups with low S.P.Rs are alike in being mainly composed of office workers, it is reasonable to assume that the observed relationships merely show that risk of hernia is appreciably reduced by a sedentary mode of life. Nevertheless, as in the case of varicose veins (Stewart and others, 1955b), this type of immunity showed signs of diminishing with age. Thus, for professional and clerical workers under 30 years of age, the S.P.R. was only 51, while for older men in these groups it was 78.

TABLE III
COMPARATIVE PREVALENCE IN TWELVE OCCUPATIONAL GROUPS†

Occupational Group	Standardized Prevalence Ratios				
	Hernia	Spinal Curvature	Rheumatic Carditis	Other Rheumatic Fever	Non-Specific Rheumatism
Professional and Administrative	80*	73*	101	121	100
Commercial ..	100	88	126	91	110
Clerical	74***	74**	119	106	65***
Boot and Shoe ..	109	149****	106	99	76***
Textile	105	96	91	93	90
Metal Manufacture	100	101	55***	97	103
Trade not defined‡	84	87	115	118	101
Warehouse ..	91	74	142*	111	115
Transport ..	107	91	80	104	96
Building and Agriculture ..	101	88	97	94	127****
Unskilled ..	104	99	101	112	116
Other Occupations	107	115*	89	86	97
Value of χ^2 for 11 d.f.	22·808	51·514	25·392	13·427	35·978
P (χ^2)	·02–·01	<·001	·01–·001	·30–·20	<·001

† Individual occupations were considered to be significantly different from standard if their contribution to the sum of χ^2 for all occupations would have been significantly large in a test based on 1 d.f. These are marked by asterisks:—
* significant at the 5 per cent. level
** " " " 2 " " "
*** " " " 1 " " "
**** " " " 0·1 " " "

‡ Occupations common to several trades (e.g. fitters, cutters, inspectors etc.).

Table IV shows that the hernia risk tended to decrease continuously with increasing height.

TABLE IV
STANDARDIZED PREVALENCE RATIOS IN RELATION TO HEIGHT

Height (in.)	Hernia	Spinal Curvature	Rheumatic Carditis	Other Rheumatic Fever	Non-Specific Rheumatism
Under 64	118	110	95	96	95
64–	104	96	92	90	94
66–	102	91	95	100	98
68–	97	96	105	105	99
70–	87	110	105	112	117
72–	73	162	136	94	115
Value of χ^2 with 5 d.f.	17·881	26·266	5·357	6·040	6·701
P (χ^2)	·01–·001	<·001	·50–·30	·50–·30	·30–·20

There was no tendency for heavy men—who are on average, tall—to have low S.P.Rs (Table V).

TABLE V
STANDARDIZED PREVALENCE RATIOS IN RELATION TO WEIGHT

Weight (lb.)	Hernia	Spinal Curvature	Rheumatic Carditis	Other Rheumatic Fever	Non-Specific Rheumatism
Under 110	94	209	180	90	81
110–	95	158	103	98	90
120–	99	116	113	96	94
130–	103	92	99	100	101
140–	101	64	105	105	102
150–	101	41	60	102	114
Value of χ^2 with 5 d.f.	1·912	258·258	40·195	2·386	9·948
P (χ^2)	·90–·80	<·001	<·001	·80–·70	·10–·05

These findings suggest that at any given height men who are overweight are more prone to hernia than men who are underweight. Fig. 1 shows the relationship between height and prevalence for two groups of men defined by body weight. At each point in the height scale men who weighed 130 lb. or more had a higher prevalence of hernia than men who weighed less than 130 lb., and in both groups the tallest men were about half as liable to hernia as the shortest.

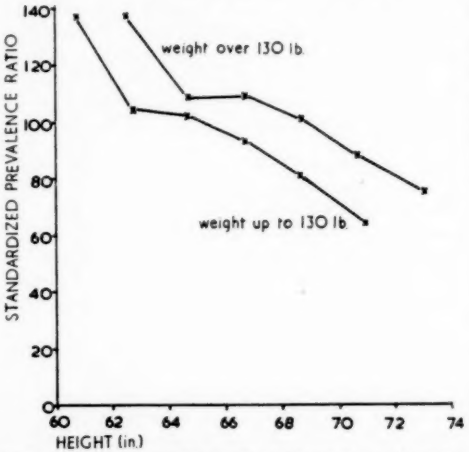

FIG. 1.—Standardized prevalence ratios for hernia in men in relation to weight and height.

It was therefore expected that (by the χ^2 criterion) hernia would show an even stronger association with body-build than with height or weight separately (Table VI, opposite).

This association is shown graphically in Fig. 2 (opposite) where the ratio Height/$^3\sqrt{\text{Weight}}$ is used to represent body-build. The appearance of

TABLE VI

STANDARDIZED PREVALENCE RATIOS IN RELATION TO BODY BUILD (HEIGHT/$\sqrt[3]{}$WEIGHT)

Body-Build	Hernia	Spinal Curvature	Rheumatic Carditis	Other Rheumatic Fever	Non-Specific Rheumatism
Stocky*	119	28	47	102	110
↑	112	48	73	101	97
	107	74	91	94	96
	99	108	107	101	94
↓	88	159	137	106	116
Slender*	77	263	183	115	121
Value of χ^2 with 5 d.f.	22·701	400·852	62·208	3·030	9·347
$P(\chi^2)$	<·001	<·001	<·001	·70–·50	·10–·05

* As the body-build scale had to be divided at slightly different points for the different conditions, numerical values of the Height/$\sqrt[3]{}$Weight ratio cannot conveniently be shown in this Table, but they are correctly plotted for the first three conditions in Fig. 2.

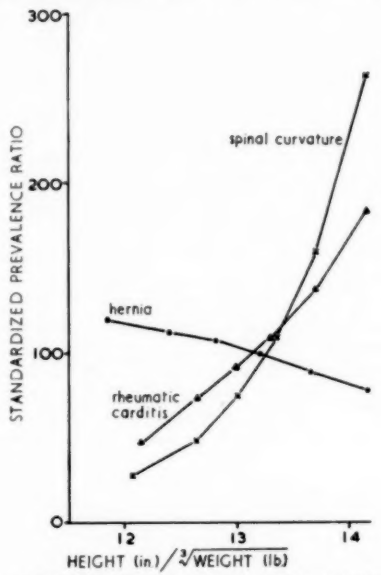

FIG. 2.—Standardized prevalence ratios in relation to body build.

this graph suggests that the relationship between risk of hernia and body-build may be adequately described by a linear equation. A very good fit to the data ($\chi^2_{(4)} = 1{\cdot}772$; $P > {\cdot}70$) is in fact given by the equation:

$$R_{(H)} = 309{\cdot}7 - 16{\cdot}04\,B$$

in which $R_{(H)}$ represents the recorded prevalence of hernia expressed as a percentage of the rate for all examinees of a given age, and B the ratio Height/$\sqrt[3]{}$Weight. Independent examination of the Leicester records has shown that this particular index of body-build discriminates as effectively between hernia cases and controls as any linear or quadratic combination of weight and height (Maynard Smith, 1955).

SPINAL CURVATURE.—A relatively small group of cases in which spinal curvature was clearly due to tuberculosis, poliomyelitis, ankylosing spondylitis, and other rare diseases is not included in the following analysis. After a preliminary analysis of the Leicester data it was decided not to retain the distinction of deformity noted by the examiners. Of the 757 cases of spinal curvature in the Leicester sample, 45 were recorded as kyphosis and scoliosis, 446 as kyphosis only, 257 as scoliosis only, and seven as not classified. The age distribution of the men with kyphosis differed slightly from that of those with scoliosis, but in respect of social class, occupation, height, weight, and body-build the two groups were almost identical.

Approximately one man in forty was reported as having a postural defect associated with spinal curvature. The prevalence rates for Leicester and Essex were similar, but (as usual) the rate for Northampton was suspiciously low. Nowhere was there anything like a regular trend in the age-specific rates, though all three regions showed an increased prevalence after the age of 35.

Social differentiation was more strongly marked than for hernia (Table II), but once again it took the form of a simple difference between manual and non-manual workers. The main feature of the more detailed occupational analysis was the high prevalence among boot and shoe operatives (Table III). In the Leicester sample these workers had an outstandingly high S.P.R. for kyphosis (168), and their ratio for scoliosis (140) was also significantly above standard. The excess of both types of spinal curvature was greater among shoemakers under 30 (S.P.R. 183) than among older men (S.P.R. 134). The hunched position of shoemakers has long been recognized as a possible danger to health and the concomitant chest deformities were at one time thought to be partly responsible for an excess of phthisis in this industry (Medical Research Committee, 1915).

The group labelled "Other Occupations" in Table III had a surprisingly high S.P.R. for spinal curvature, and this was eventually traced to workers in wood, cane, and cork (Main Order XI, General Register Office, 1951). In Essex, where there were many such workers, their S.P.R. was 183; a ratio as different from the other trades in this locality as were the ratios for shoemakers in Leicester and Northampton.

The relationship between spinal curvature and height (Table IV) was not straightforward. Prevalence was at a minimum for men of average height and there was an excess of cases among both tall and short men. The latter finding could be interpreted as a result of spinal curvature, but not so the much larger excess among tall men. On the weight scale (Table V) the highest S.P.R. (which is over 200) is found among the lightest men, and with increasing weight the prevalence falls precipitately to one-fifth of the maximum. Even this extreme variation is less than that associated with body-build (Table VI), for, in passing from the stocky extreme of the Height/$\sqrt[3]{\text{Weight}}$ scale to the slender extreme, there was a more than nine-fold increase in the S.P.R. (28 to 263). The intermediate points on the graph shown in Fig. 2 lie near a smooth curve, and the data were sufficiently regular to give an extremely close fit ($\chi^2_{(4)} = 0{\cdot}639$; $P > {\cdot}95$) to the exponential equation:

$$R_{(SC)} = 2{\cdot}909^{B} \times 10^{-4{\cdot}156}$$

in which $R_{(SC)}$ is the recorded prevalence expressed as a percentage of the rate for all examinees of a given age, and B the ratio Height/$\sqrt[3]{\text{Weight}}$. The value of χ^2 associated with the one degree of freedom in this regression is just over 400. An equally strong association between slender build and spinal curvature was found in the separate records of each of the three regions.

RHEUMATISM.—The diseases which we have grouped under the general heading of rheumatism included 598 cases of rheumatic carditis, 1,308 of rheumatic fever without evidence of heart involvement, and 1,303 with less precise diagnoses such as arthritis, fibrositis, and muscular rheumatism.

Rheumatic Carditis.—This is principally a disease of young children and one which has an appreciable death rate within a few years of its outset. Consequently the sample of cases seen by Civilian Medical Boards must over-represent those which, for one reason or another, had the best prognosis. To what extent this has affected the prevalence rates in the three regions it is impossible to say, but in this case Northampton had many more cases in relation to the number of men examined than Essex or Leicester (Table I). In all three regions the prevalence rates increased slightly up to the age of 35 and thereafter declined, suggesting that in the fourth decade of life deaths among late survivors begin to outnumber new cases.

Both case rates and mortality rates for rheumatic carditis are known to be relatively high among the labouring classes. The evidence of an even social class distribution in Civilian Medical Board records (Table II) suggests that prognosis may be better for the well-to-do persons than for the poor.

The occupational distribution of men with rheumatic heart disease (which must be regarded as a result rather than a cause of their disability) suggests that such men tend to congregate in warehouses, shops, and other commercial undertakings, and find difficulty in entering the metal, engineering, and transport industries (Table III).

The absence of any significant relationship between rheumatic carditis and height (Table IV) is an indication that in these late survivors there had been no stunting of growth. On the other hand the prevalence of the disease was three times greater at the light than at the heavy end of the weight scale (Table V), and nearly four times greater among excessively slender men than among men who were exceptionally heavy for their height (Table VI and Fig. 2). These findings are equivocal: they may indicate that men of ectomorphic build are particularly prone to rheumatic carditis, but equally they could be due to loss of weight from chronic ill health. The difference in average weight between the men with and without rheumatic heart disease (4½ lb.) is approximately the same as the difference between peptic ulcer subjects and other men examined by Civilian Medical Boards (Stewart and others, 1955d).

Other Cases of Rheumatic Fever.—The records used by Civilian Medical Boards invited a yes/no answer to the question "Has the examinee ever had rheumatic fever?" It is likely therefore that in respect of this disease the standard of recording is more uniform than usual and that the even regional prevalence rates for rheumatic fever (with and without heart involvement) can be taken at their face value (Table I). Although the prevalence rates for rheumatic carditis declined after the ages of 35, those for histories of uncomplicated rheumatic fever continued to rise. This is no doubt partly due to the declining incidence of the disease in recent decades, and partly to the fact that there are no delayed deaths.

The even social class distribution of uncomplicated rheumatic fever suggests that well-to-do persons, besides tolerating the strain of a damaged heart better than poor persons, also have a better chance of surviving the acute phases of rheumatic fever.

As would be expected with a childhood disease which has produced no residual effects, there were no points of interest in the occupational analysis (Table III). Nor were there any significant associations with height, weight, or body-build (Tables IV, V, and VI). This makes it very probable that the association between rheumatic carditis and slender

build was due to loss of weight, for if any constitutional predisposition had been involved it should have appeared in the cases without permanent heart damage.

Non-Specific Rheumatism.—In the transcription of the Leicester records all cases of arthritis, fibrositis, and muscular rheumatism were coded together so that separate analyses were possible for only two of the three regions. Since there is in any case considerable difficulty in making a firm diagnosis, the three conditions have been treated as one in the Tables, and in the text they are referred to collectively as non-specific rheumatism.

The gross disparity between the recorded frequency of non-specific rheumatism in Essex (where there were particularly large numbers of cases diagnosed as arthritis) and in the other two regions must be attributed to different standards of recording, and is a reminder that Civilian Medical Boards records should not be used to estimate absolute prevalence. In all three regions prevalence rates increased rapidly with age, and by the early forties they were fifteen to twenty times as high as in the late teens.

Though there appeared to be no tendency for these diseases to vary from one social class to another (Table II), there were distinct occupational differences (Table III). Clerical workers had a low prevalence both of arthritis and of other types of non-specific rheumatism. The deficiency of cases among shoe operatives was greater for arthritis (S.P.R. for Northampton and Essex, 63) than for other types (S.P.R. 83). The mixed building and agriculture group owed its excess of cases to a remarkably high prevalence of all forms of non-specific rheumatism among farm workers (S.P.R. 152).

The height, weight, and body-build analyses yielded inconclusive results. From a preliminary study of the Leicester records it looked as though non-specific rheumatism might be associated with physical bulk and in particular with stocky build (though the highest individual S.P.R. actually occurred at the slender extreme of the body-build scale). However these findings (which where significant at the one per cent. level) were not adequately confirmed in Essex and Northampton. Results for the three regions combined did show a continuous increase in prevalence with weight (Table V) and an excess of cases at both ends of the body-build scale, particularly the slender extreme, but in both cases the departures from standard were of doubtful significance ($0{\cdot}10 > P > 0{\cdot}05$). A separate consideration of the diagnostic groups in Essex and Northampton suggested that slender men might be unduly prone to arthritis and heavy men to muscular rheumatism, but once again the observed variations might have been due to chance.

Discussion

The present study has disclosed two more examples of what appear to be functional relationships between risk of disease and body-build. Equations relating prevalence of a particular disease to body dimensions should not, of course, be interpreted in anything but a descriptive sense. But it is of considerable interest to find that the variable Height/$\sqrt[3]{\text{Weight}}$ (despite its lack of a precise physiological significance) has distinguished groups of men between which the prevalence of inguinal and femoral hernia varies by a factor of 1·5, and that of spinal curvature by a factor of 9. Differences of this magnitude cannot be ignored in any discussion of aetiology, particularly when, as in the case of spinal curvature, a recent attempt to classify the disease on a causative basis ended by 90 per cent. of the cases being labelled "idiopathic" (Osmond-Clarke, 1950). Moreover, although there is no simple explanation why a low Height/$\sqrt[3]{\text{Weight}}$ ratio should predispose to hernia, there is good reason to suppose that a man whose spine is unusually long will have difficulty in maintaining a correct stance if there is no corresponding development of his spinal muscles.

There appears to be at least one occupation which is conducive to spinal curvature (shoemaking), and one in which the risk of hernia and of spinal curvature is considerably reduced (clerical work), but in both these occupations the deviation from standard was less noticeable among older than among younger workers. These two examples of an occupational influence showing its greatest effect in the early years of working life, and the one already cited in connexion with varicose veins, show that it is a mistake to assume that the effects on health of a particular type of work necessarily become more marked with the passage of time. When environmental factors merely hasten or delay the manifestation of a defect which is inherent in an individual's constitution, the reverse may well be true.

Summary

A study has been made of various social and physical characteristics (economic status, occupation, height, weight, and body-build) of men who, at the time of their pre-service medical examination, were recorded as having hernia, curvature of the spine, rheumatic fever, or other (non-specific) rheumatic complaints.

Social Classes I and II were relatively free from hernia and spinal curvature, but among manual workers (Social Classes III, IV, and V) no variations in prevalence were found which could be ascribed to economic status as such.

Hernia, spinal curvature, and non-specific rheumatism were all rare among clerical workers. Spinal curvature was common among boot and shoe operatives and also among workers in wood, cane, and cork. Non-specific rheumatism was common among farm workers and relatively rare among boot and shoe operatives.

The outstanding findings in relation to body dimensions were that risk of hernia could be represented as a decreasing linear function and risk of spinal curvature as an increasing exponential function of a body-build index (Height/$\sqrt[3]{\text{Weight}}$). The significance of these and other findings is discussed.

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